

Subterranea

The Magazine for Subterranea Britannica



Subterranea Britannica



August 2019 Issue 51

IN THIS
ISSUE

Berlin Study Weekend
Standedge Tunnels Visit

Swiss Underground Fortresses
Creswell Crags Discovery

Subterranea Britannica is a society devoted to the study of man-made and man-used underground structures and the archaeology of the Cold War. The society is open to all and its membership includes all walks of life. Members are invited to contribute to this magazine even if this just means sending very welcome snippets from newspapers and magazines.

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Front cover photo: *Fort San Carlo, Switzerland: One of the two slope shafts linking the fort's subterranean works with the 10.5cm gun turrets on the surface. To the left-hand side is the electrically-powered, chain-driven ammunition hoist. The stairs are fitted with rails, allowing a replacement gun barrel to be winched up to the turret on a cradle. Fort San Carlo was the first of the WWII artillery forts to be commissioned within Fortress Gotthard, and effectively served as the prototype for a new generation of Swiss turret forts. Photo Tim Wellburn*

Back page upper: *A British Waterways volunteer guides a specially-built canal vessel along the Huddersfield Narrow canal during SubBrit's recent marathon behind-the-scenes visit to the Standedge Tunnel. Visible above is the brick lining of the Dingle extension of the tunnel, one of four driven through the Pennines. Photo Gerald Tompsett*

Back page lower: *Sub Brit members and local guides gather in front of the remains of the model T750 air-raid shelter located near the Koralle bunker; the command HQ of the Kriegsmarine, the 'T' being short for Truppenmannschaftsbunker (Troops crew bunker), and 750 the nominal number of occupants. Photo Neil Iosson*

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However the Editor reserves the right not to publish material without giving a reason.

The committee of Subterranea Britannica and the Editor do not necessarily agree with any views expressed and cannot always check the accuracy of any material sent in.

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Chairman's Welcome

Martin Dixon

We had a good turnout at our Spring Meeting and AGM in April and a first-class set of presentations covering everything from Witch Marks at Creswell Crags (discovered by our own Hayley Clark and Ed Waters) to underground military defences across Scandinavia (Lars Hansson) and the outstanding restoration project underway at the former ROTOR station at Barnton Quarry in Edinburgh (Grant More). This last presentation was put into context and brought to life by reminiscences from Sub Brit member Keith Jeffery who had served at Barnton in the 1950s and recalled amongst other things having to dodge RAF Police dogs on the night shift. Thanks to Phil Catling and all presenters for delivering such a fascinating programme.

Also at the Spring Meeting we relaunched the Sub Brit main website (www.subbrit.org.uk). One of the consequences of having had such an early website is that it had grown organically and much was well away from current standards. After a huge amount of work by our webmaster Richard Seabrook we now have something which is more robust, and also presents in a more flexible way across a wide range of devices. If you haven't visited our website lately, you should certainly take a look.

Equally importantly, adding new underground locations to our new website is much easier. We will be looking for members to contribute to extending our online coverage – we already have around 2,500 structures but there are many more that aren't (yet!) included. The website is our 'shop window' and provides a valuable resource to researchers and enthusiasts alike. It also acts as an important way to gather new members, many of whom first find out about Sub Brit from the web. I'm sure

you'll join me in thanking Richard for his dedication and commitment in delivering this major upgrade.

Our next day Conference is at a new venue. We normally alternate our Autumn Meeting between the Royal School of Mines and somewhere else in the UK – in recent years we've visited Liverpool, Newcastle, Belfast and Nottingham. The Royal School of Mines has, however, stopped renting out their lecture theatres during term time so we've opted to hold the meeting at Reading University. Reading is easily reached by train from across the UK and the University campus is served by a frequent bus service from the station. There's also lots of free car parking for those who prefer to drive. The facilities appear to be first-rate and I hope to see lots of members old and new on Saturday 19 October. The programme and further details are of course on mySubBrit.org.uk.

The Reading Campus also includes the 1953 Reading War Room which later became the communications centre for Warren Row Regional Seat of Government (RSG 6). Warren Row itself is constructed in a former chalk mine, and was made famous by the 'Spies for Peace' protest in 1963 when protesters gained access and their trespass hit the press. Sadly our attempts to get access to the War Room (or 'Citadel' as the University now terms it) have proved unsuccessful up to now as it's off-limits even to University staff. At least the structure benefits from listed building protection so it should be around for some time to come.

Let us hope the summer is kind to us all and if we're faced with further heatwaves then remember it's always cool underground so just head downwards – the core's the limit!

chairman@subbrit.org.uk



Reading Regional War Room in 1999. Photo Nick Catford



SUBTERRANEA BRITANNICA DIARY

Summary of Forthcoming Events

Sub Brit specific events

2019

- 28 September Committee Meeting
12 October Private Bunker Visit, Somerset
19 October SB Autumn Meeting, Reading University
1 November Copy deadline for *Subterranea* 52
5 November Visit to Fiddler's Ferry Power Station, Cheshire
Mid-December *Subterranea* 52 published
8 February 2020 Committee Meeting
25 April 2020 Sub Brit AGM and Spring Meeting, London

Other underground-related events

2019

- 31 August - 29 Sept Heritage Open Weekends, Scotland
14 September Reigate Caves Open Day
13 - 22 September Heritage Open Days, England
14 - 15 September European Heritage Open Days, Northern Ireland
21 - 22 September London Open House
September month Open Doors, Wales
18 - 20 October SFES Congrès (Lyon, France)
3 - 6 April 2020 NAMHO Weekend (Cornwall)

For web links to these events please visit www.subbrit.org.uk/events
or contact the organisation concerned

*If you know of other relevant events run by other societies, please let us know
so that they can be advertised in the next edition and on the website*



Subterranea Britannica Annual General Meeting 2019

Minutes

27th April 2019, Lecture Theatre G20, Royal School of Mines, Imperial College, London.

The meeting was opened at 10.10 by the Chairman, Martin Dixon, who welcomed all those attending. 65 members were present.

1. Apologies for absence were received from Stewart Angell, John Burgess, Nick Catford, Liz Gray, Jason Hughes, John Lill, Jon Maisey, Bill Ridgeway, Joan Ridgeway, Richard Seabrook, Chris Wall, Nigel Wall, Tim Wellburn and Stewart Wild.
2. The Minutes of the AGM 2018 were published to all members in *Subterranea #48*, August 2018. It was proposed by Alistair Graham Kerr, seconded by Bob Clary, that the Minutes were a true reflection of the meeting; the proposal was accepted with one abstention.
3. Annual Report. This has been published to all members and is on Sub Brit's web site. Martin highlighted some of the key activities during 2018 and thanked all members who had contributed, both visibly and behind the scenes. Sub Brit arranged weekends based in Nottingham and Budapest; there were also a good number of day visits including Mail Rail 'walk the track', Paddock standby Cabinet War Room, Thames Tideway River Tour, RAF Daws Hill, Cambridge War Room/RSG, RAF Lakenheath, Williamson's Tunnels and Queensway Tunnel, Grantham Reservoir and RAF North Witham and others. This enabled several hundred Sub Brit members to go underground.
4. Statement of Financial Activities: Sub Brit's Accounts have been signed off by the Committee and Independent Examiner and have been filed at Companies House and the Charity Commission.
5. The motion proposed by the Committee to increase the Annual Subscriptions to the Society to £25 (£35 Overseas) per annum, with immediate effect was carried unanimously
6. The motion that nominations for Sub Brit's Committee be considered '*en-bloc*' was proposed by Sam Marko and seconded by Paul Sowan. The motion was carried unanimously.
7. The motion to elect the following Committee members for 2018/19 was carried unanimously. There are still vacancies for more members to join the Committee – please get in touch if you'd like to come along to a meeting to see how it works.

The elected Committee for 2019/2020 is:-

Martin Dixon	Chairman
Richard West	Vice Chairman
Linda Dixon	Secretary
Nick Catford	Membership Secretary
Tony Radstone	Treasurer
Phil Catling	Member
Alistair Graham Kerr	Member
Chris Gray	Member
Jason Hughes	Member
Richard Seabrook	Member
Paul Sowan	Member
Bob Templeman	Member
Tim Wellburn	Member

The Meeting officially closed at 10.30.

Martin then outlined a number of forthcoming events including Churchill War Rooms private tour (22 May), Standedge Canal Tunnel transit (13 June), Sub Brit Autumn Meeting (19 Oct) and a further Mail Rail 'behind the scenes' on 5 August.



Owen Ward 1930 – 2019

Martin Dixon

We are sorry to record the passing of long-term member Owen Ward.

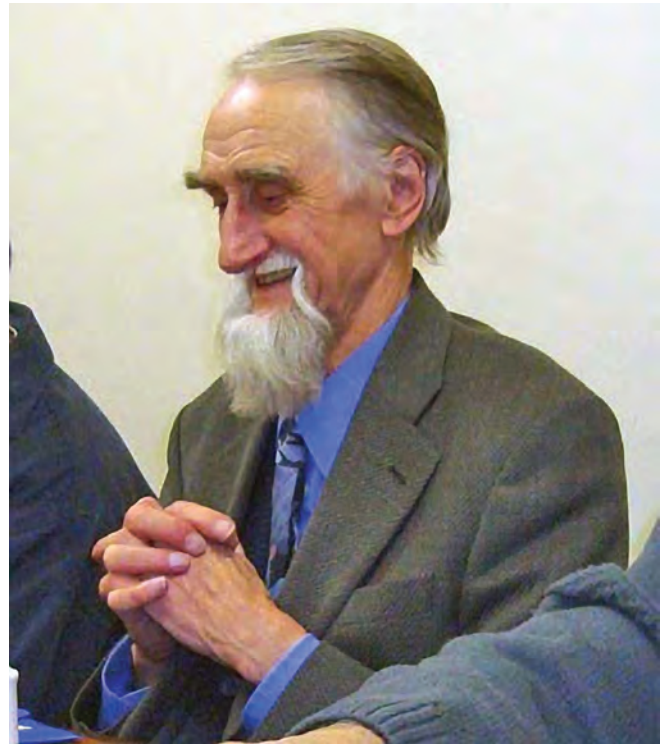
Owen lived in Bath and was knowledgeable about the Bath stone industry but had a special interest in and knowledge of Molinology – the study of water and windmills and (in Owen’s case) the millstones that many of them use.

Born in Southampton, Owen was evacuated during World War II and sadly his mother died while he was absent. He returned to Southampton to go to University, where he read Music, English and French. After qualification he spent time teaching in France where he met his wife Leila with whom he had 64 years of happy marriage.

He returned once more to Southampton as a teacher but later moved to Bristol to work in college administration. Eventually the College moved to Bath and became the University of Bath, and Owen and Leila moved there too.

Owen joined Sub Brit around 1980 and both he and Leila were frequent attendees at conferences and visits. Owen was particularly helpful during the 1992 International Conference organised by Sylvia Beamon and others in Bath.

Like many Sub Brit members, Owen had many strings to his bow – in his case literally. He was Musical Director of the Bristol Amateur Operatic Society and a member of a men’s singing group at Bath University. He was also a founder member of the Bristol Industrial Archaeological



Society which celebrated its 50th anniversary in 2017. He contributed many papers to journals and published a book on the Millstone Industry in parts of France.

We send our condolences to Leila and the rest of Owen’s family.

James Whitaker Wright’s underwater ballroom at Witley Park, Surrey

James Whitaker Wright [1846 - 1904] was a financier who had a hand in, amongst other matters, the development of the Bakerloo line. Numerous of his financial dealings were found to be fraudulent, on account of which he was tried and found guilty. Facing a lengthy prison sentence, he committed suicide by taking cyanide.

In or about 1890 he had built for himself a neo-Tudor mansion since called Witley Park, and set about landscaping the grounds. Below the lowermost of three artificial lakes he constructed a circular room lit by a glazed dome the window panes of which were of three-inch-thick glass. The approach was down a spiral staircase of concrete steps and a concrete underwater tunnel. A mid-water statue of Neptune bearing a trident surmounting the dome concealed a ventilator duct. Although Wright’s mansion has now been demolished it appears that the underwater structure, and the statue, survive. Photographs, for which dates and sources are not cited, are reproduced in Peter Tarplee’s paper.



SOURCES: TARPLEE, Peter, 2019, James Whitaker Wright and a local mystery. *Newsletter Surrey Industrial History Group* 222, 12 – 14; and NAIRN, Ian, and Nikolaus PEVSNER, 1971, *The Buildings of England: Surrey*. 2nd edition. Penguin Books, pages 531 – 532.



NEWS

Miscellany compiled by Paul W Sowan and Nick Catford

NEWS – ARCHAEOLOGY

Skeletal remains of Mesolithic persons found in Somerset cave

Human bones of proven Mesolithic (Middle Stone Age) date are rare in the UK, only a few more than 20 sites having been identified. The only recorded nearly complete skeleton from this period is that of ‘Cheddar Man’ from Gough’s Cave dated to around 8250 BC. The number has been added to as a result of examination of two cardboard boxes of bones from a cave held at the Museum of Archaeology at Taunton.



Cheddar Man is on display in the Natural History Museum in London, with a replica seen here on display in Gough’s cave

The bones are from at least seven individuals, along with those of badger, cattle, deer and horse. Their state of preservation embedded in a cemented cave floor breccia suggests a deliberate cave burial, rather than material fallen in from an earth grave nearer the surface. When discovered in the 1960s they were thought to be of Roman or later date, but have now been carbon dated to 8545 – 8325 and 8240 – 7975 BC, comparable with ‘Cheddar Man’ at 8250 BC. Cannington Park Cave was revealed by quarry blasting, and has now been destroyed by further extension.

SOURCE: PITTS, Mike, 2019, Mesolithic burial surprise from Somerset cave. *British Archaeology* 166, page 7.

Early Medieval cemetery at Aveline’s Hole, Mendip Hills, Somerset

Aveline’s Hole is a natural cave in the Carboniferous Limestone of the Mendip Hills, near Burrington Combe. It is named after Henry Thomas Aveline [1819–75], an early investigator. When first explored in 1797 it was found to contain skeletal remains of at least 50 persons. Numbers of the bones vanished over the years, taken as souvenirs so undocumented and lost to science. In due course such as remained were accommodated at the University’s museum at Bristol which unfortunately was

hit by a bomb during World War II. The bones survived, but labels and documentation suffered losses.

Nevertheless, modern scientific testing has established that the human remains were the result of deliberate burials made over a period of years in early Mesolithic times. More recent work has now established that this subterranean cemetery was used again over 4,000 years later in the Neolithic. The research leading to this conclusion has included tracing and identifying Aveline’s Hole material from that which survived the 1941 bombing, and modern DNA analysis and isotopic dating. Reference is also made to related nearby sites at Badgers Hole, Cannington Park Quarry, and Greylake. SOURCE: SCHULTING, Rick J., *et al.*, 2019, Aveline’s Hole: an unexpected twist in the tale. *Proc. University of Bristol Spelaeological Society* 28(1), 9–63.

Roman ceramic pot found in Wookey Hole, Somerset

Cave divers have found a Roman pot and associated sherds in a flooded part of Wookey Hole. The items have been brought out, and identified as having been made in the third or fourth century AD either in Oxfordshire or in the New Forest in Hampshire. The finds will be exhibited in the museum at Wookey.

SOURCE: THOMAS, Michael, 2019, Roman Wookey. *Descent* 267, page 7.



Eleventh-century cellars and undercrofts at Hereford

A survey of historic houses in Hereford has revealed that there are numerous 11th-century and later cellars and undercrofts surviving, or recorded and known to have existed, under the city. The oldest known example dating from the mid-11th century is a stone vaulted structure excavated in 1993 at the site of the new library building southwest of the Cathedral, built to house the *Mappa Mundi*. Others are known for example at Elgin Street, St Peter’s Street, and Widemarsh Street. Similar examples are at Chester, Norwich and Winchelsea. There are two known and still accessible at Guildford in Surrey, and one

(largely and possibly completely destroyed) in Croydon in Greater London.

SOURCE: CATLING, Chris, 2019, Hidden in plain sight: searching for Hereford's historic houses. *Current Archaeology*, 30 (1) (349), 42–51.

Historic England to cease publishing

A few years ago the government body known as English Heritage was split into two. One part became an independent charity intended to be self-financing and responsible for the portfolio of buildings and field monuments. That part retained the name English Heritage, to avoid the cost of changing so many signposts, information boards and so forth. Government legal oversight of Listed Buildings and Scheduled Ancient Monuments &c was retained by a new body named Historic England.

Historic England also retained a publishing programme and responsibility for the production of high quality monographs. That publishing function is now to cease. One of the last publications to be issued was John Barnatt's book *The archaeology of underground mines and quarries in England*. The book, published this year, has been awarded the Peter Neaverson Award for Outstanding Scholarship by the Association for Industrial Archaeology.

SOURCE: ANON, 2019, Historic England to give up publishing. *Industrial Archaeology News* 188, page 11.

NEWS - CONSERVATION AND HERITAGE

Egypt's 'Bent Pyramid' opens to visitors

Egypt's has opened to visitors the Bent Pyramid near Cairo, in a move that is part of a wider push to boost tourism. The Bent Pyramid at Dahshur was built for pharaoh Snefru about 2,600BC, and was originally designed as a "true" pyramid with the steep 54-degree angle. But the pyramid was being built on soft, silty clay – and there was a problem with stability and subsidence. This was solved by adjusting the angle to a flatter 43 degrees, 147ft up the face. The angular shape contrasts with the straight sides of the Red Pyramid just to the north.



79m entrance tunnel

Visitors can now clamber down a 79m narrow tunnel from a raised entrance on the Bent Pyramid's northern side to reach two chambers deep inside the structure. Archaeologists also presented mummies, masks and tools discovered during continuing excavation works that began near the Dahshur pyramids last year.

SOURCE: BBC News, 13 July 2019.

Government supports Welsh Slate Industry proposal for World Heritage status

Government support has been announced for proposed World Heritage status for the slate quarrying landscape of Gwynedd in North Wales. Surviving buildings and plant, underground quarries, waste tips and transport infrastructure are to be included. The quarries once 'roofed the world', the slate being used internationally as a durable and much lighter alternative to baked clay tiles.

SOURCE: ANON, 2019, Government announces its endorsement of the Slate Industry to the World Heritage List. *Industrial Archaeology News* 188, page 18.

All change for the Clifton Rocks Railway

The Clifton Rocks Railway cut out of the rocks of Bristol's Avon Gorge more than 125 years ago could be brought back to life as the city's newest tourist attraction. The railway has been purchased by Ian Johnson, the businessman who also owns the nearby Clifton Observatory. Johnson's plans are to open a museum at the upper station seven days a week and gradually restore the historic railway to its original Victorian glory.

Maggie Shapland of Clifton Rocks Railway Trust said: "We look forward to the next chapter of our story when we work with Ian, having worked at the Railway as volunteers since February 2005 and done a huge amount of research and refurbishment since, and put the Railway firmly on the map. This is very early days and we know Ian's ideas are broadly in line with ours which pleases us no end. We are very privileged to be asked to advise



and help with the project and take it to its next level as a museum experience.”

The Clifton Rocks Railway has been visited by members of Subterranea Britannica on several occasions and was first entered in September 2001 when Nick Catford got permission from the then owner, the Avon Gorge Hotel, to cut the padlocks off at the upper station and enter the tunnel for the first time in many years.

SOURCE: *Bristol 247.com*, 30 April 2019.

Israel opens ancient Pilgrims’ road to the public

Israel has unveiled an ancient road Jesus is said to have used to reach the Temple in Jerusalem after an £80million project to excavate it from beneath a Palestinian neighbourhood.

The 2,000-year-old ‘Pilgrim’s Road’, which served as the main thoroughfare for visitors to the ancient Jewish temple, was discovered by accident in 2004 by workmen mending a broken pipe in a potato field. The 350-yard road led to the temple from a spring known as the Pool of Siloam, where pilgrims would cleanse themselves before visiting the temple. The project to excavate beneath the mostly Palestinian neighbourhood of Silwan was funded by donors including Russian billionaire Roman Abramovich.



Visitors will be able to ‘touch history’ by walking in the footsteps of ancient pilgrims through a stretch of tunnel along the ancient street that ran uphill to the Jewish temple.

SOURCE: *MailOnline*, 4 July 2019.

Plans for Kent Mining Museum scuppered

Plans to turn the former Betteshanger colliery into a sustainable energy park and mining museum appear to be in tatters after it emerged that the college group behind the £40 million scheme has put the site up for sale. Set among the 250-acre country park, it is meant to become home to Kent Mining Museum, a green energy centre, cycle hire and change facilities, learning and conference spaces, a shop, a café and outside seating and decking.

The scheme had been set to transform the former mining community, with the £9.5 million museum said to be “85 percent finished” as part of the first stage of investment.

Yet it was all left hanging in the balance when the owner of the site, Hadlow Group, was plunged into chaos earlier this year.



Betteshanger Colliery after closure in 1989.

Photo Nick Catford

Its chief executive Paul Hannan and his deputy Mark Lumsdon-Taylor were both suspended after the Further Education Commissioner launched an investigation into the group’s activities. The Education Skills Funding Agency said the group is in “inadequate financial health”. Work on the Betteshanger Park stopped as the investigation into Hadlow Group got underway while plans to dispose of the site by the end of July have been expressed. Dover and Deal MP Charlie Elphicke organised a series of talks to discuss the future of the museum which was originally forecast to open in March 2019.

SOURCE: *Kent Online*, 17 May 2019.

NEWS - HEALTH AND SAFETY

Caver dies in Yorkshire Dales during 17-hour rescue attempt

Caver Harry Hesketh died in the Yorkshire Dales during a 17-hour rescue attempt involving nearly 100 volunteers co-ordinated by the Clapham Cave Rescue Organisation (CRO). Mr Hesketh is said to have broken his leg in a fall deep within a cave at Curtain Pot, on Fountains Fell, North Yorkshire, on 1 June. He died before being brought to the surface.

The narrowness of the passages in an unmapped part of the cave caused difficulties for rescuers. Mr Hesketh, who had been part of a group of three cavers, received aid from a doctor assisted by trained casualty carers. Unfortunately, due to the nature of his injuries, and the extended time needed to create a navigable way out, he succumbed to his injuries and died just prior to the extrication beginning.

The attempt to rescue Mr Hesketh took 1,600 volunteer hours and “virtually every piece” of caving equipment in CRO stores. Due to the severity and urgency of the situation, a lot of equipment was sacrificed to expedite the potential extraction of the casualty



The voluntary organisation has made an appeal on its Facebook page to replenish its equipment, medical supplies and food and water. More than £10,300 was raised in nearly 24 hours.

SOURCE: *BBC News*, 3 June 2019.

Cave rescue reports for 2017

In 2017 Cave Rescue teams responded to requests mostly received via the emergency services for assistance for 73 persons featured in incidents above ground, and nine underground. Natural caves featured in 24 underground events for which summaries of details are provided, of which three were in tourist show caves. Eight incidents were related to man-made underground mines and quarries, such as are visited by *Subterranea Britannica*.

Noteworthy, six searches are reported in the Box and Brown's Folly quarry tunnels in Wiltshire. Four reports feature the extensive labyrinth of building-stone quarry tunnels at Box, where four visiting groups became lost, some as a result of an alternative exit having been closed and failure to find their way back to where they had entered.

The one underground fatality is unexplained. A search for a single person reported missing resulted ultimately in the discovery of the decomposing body of a 68-year-old man who is thought to have died in Ewes Top Moss Pot on Scales Moor up to four months earlier. At the other end of the scale, two persons who had tripped and suffered minor injuries were assisted out of the Great Masson and White Scar show caves in Derbyshire and Yorkshire. SOURCE: BRITISH CAVE RESCUE COUNCIL, 2019, *Cave rescue 2017. Descent* 267, 29–31.

Accident at Sibanye gold mine, South Africa

Sibanye Gold was ordered to shut down the shaft at its Rustenburg platinum mine on 2 May, where 1,800 workers were trapped for 10 hours on Tuesday 30 April 2019, due to an accident with an underground transport system. Rails being transported underground fell down the shaft, blocking it. There were no injuries as a result of the accident, but miners had to remain underground while the shaft infrastructure was checked.



The company claimed that the miners were never in any danger as it was always possible for them to use an adjacent shaft to hoist the workers to the surface if

necessary. The Department of Mineral Resources issued a so-called Section 54 notice, barring the company from resuming operations at Thembelani shaft until a government mines inspector is satisfied that it's safe to do so.

The incident 0.9 miles underground at one of Rustenburg's four shafts revived concerns about safety at Sibanye's operations. Last year, there was a spike in fatal accidents at the company's gold mines; some of the world's deepest. About 1,000 workers were trapped underground for more than a day at one of its gold mines in February 2018 after a power failure.

SOURCE: *Below*, the journal of the Shropshire Caving & Mining Club, Summer 2019.

NEWS - MILITARY AND DEFENCE

WWII and Cold War bunker in Norfolk goes under the hammer

A former underground bunker and Cold War command centre has been sold by auction. The bunker, which had a recommended price of £10,000 to £20,000, is located on the former RAF West Raynham site, near Fakenham. Dating back to 1939, when the airfield was opened, the bunker first served as a decontamination centre for the unwounded during the Second World War.



It was then upgraded to a command centre during the Cold War, but following the Ministry of Defence's closure of the RAF site in 1994, the bunker was sealed. It is one of 44 lots on the West Raynham Business Park, priced at £5,000 to £200,000, on sale at the site. The auction took place at Dunston Hall Hotel on the Ipswich Road on 17 July.

SOURCE: *Eastern Daily Press*, 12 July 2019.

Cold War monitoring post excavated near Wokingham, Berkshire

An archaeological excavation on the route of the intended Arborfield Relief Road near Wokingham has revealed a Royal Observer Corps Underground Monitoring Post built in 1961 on the site of an earlier (World War II) monitoring post built above ground in 1936. Surviving surface structures were demolished in the 1970s leaving only the monitoring room intact.





*The excavated roof of the monitoring room.
The truncated vent shaft is seen at the near end*

The Cold War post was in use from 1961 to October 1968. What remains is due to be ‘fully removed’ before road construction commences. Wokingham Borough Council is working closely with the Arborfield Local History Society on plans to install a memorial stone as a fitting tribute, dedicated to the brave members of the Arborfield Royal Observer Corps.

SOURCE: WESSEX ARCHAEOLOGY, 2019, Cold War monitoring post uncovered near Wokingham. *Current Archaeology* 30(30)(3), page 13.

Rhydymwyn Valley Works – Tunnel tours

The Rhydymwyn Valley History Society run regular tours in the tunnels that once housed the UK’s supply of chemical weapons. Sub Brit helped fund the provision of safety equipment to allow the tours to take place.



Photo Gareth Hacking

Booking details are at
www.rhydymwynvalleyhistory.co.uk/events

SOURCE: Martin Dixon.

Cold War relics in Albania

After some 40 years of communist rule under Enver Hoxha, who died in 1985, Albania is now becoming a tourist destination. His sumptuous villa in Tirana was, during that period, in a closed part of the city inhabited and visitable only by the communist party elite and their families. This district is now packed with bars, night clubs, and restaurants. The building has been boarded up and closed, its contents and furnishings unchanged for over a quarter of a century.

From the basement there is an escape tunnel, a precaution for if attacked. Elsewhere in the city there is a massive bunker with five floors below ground level, now a public museum. This is perhaps the largest of about 168,000 concrete bunkers created in eight years, inspired by Hoxha’s visit to North Korea.

SOURCE: WALKER, Sean, 2019, The house that Hoxha built. Dictator’s ghostly villa casts shadow over modern Tirana. *The Guardian*, 28 June 2019, 26–27.

Plans to turn historic Drakelow Tunnels into wine warehouse

The former WWII Rover cars shadow factory and Cold War RSG and RGHQ near Kidderminster could be turned into a wine storage facility under new plans submitted to the district council. London City Bond wants to develop the historic Drakelow Tunnels beneath Kingsford Country Park into a warehouse and distribution centre for 10,000 tonnes of wine, creating 40 full-time jobs.

In recent years, the tunnels have welcomed members of the public for regular open days which would be stopped altogether if plans went ahead.



The RSG kitchen. Photo Nick Catford

A company spokesman said: “LCB’s proposal for the site involves bringing the Drakelow Tunnels back into a commercial use, the purpose for which they were constructed in the first place in the 1940s. It also ensures that the historic tunnels will be properly maintained, which could otherwise be a costly exercise.” Wolverley and Cookley Parish Council were due to discuss the proposal on 4 June.

Michael Scott, tour guide for the Drakelow Restoration Volunteers, said: “We can confirm the planning application has been submitted but at this present time it is business as usual.”

SOURCE: *Kidderminster Shuttle*, 16 May 2019.

WWII Bunker Museum opens at Mallacoota, Australia

A restored Royal Australian Air Force advanced operations bunker at Mallacoota (Victoria), part of a chain



of high security World War II defence bases protecting the coastline, is now open to the public on Tuesdays and additional days during holiday periods and for groups by arrangement. A picture postcard issued by the Mallacoota & District Historical Society shows the museum to be at least partly underground. The museum is at Airport Road. For details contact it at PO Box 151, Mallacoota, Victoria 3892 / www.mallacootabunker.com.au

SOURCE: Michael Thomson.

Paddock tours suspended

Members may have noticed that the normal open days for the Paddock bunker at Dollis Hill aren't in the Sub Brit diary. This is because the site owners (Network Homes) have suspended access to the site after an internal review. We are working with Network to see if we can find a way to reopen the site for future visits.

SOURCE: Martin Dixon.



Photo Nick Catford

NEWS - MINES AND MINING

Colliery winding engine restored at Great Western Mine near Pontypool



Sixteen years of work by volunteer conservationists has

been rewarded by the completion to working order of the colliery winding engine at the Great Western Mine at Hopkinstown near Pontypool in South Wales. The steel headframe, winding engine and engine house have Listed Grade I and Scheduled Ancient Monument status, and date from 1896. The associated fan house is Listed Grade II. The project attracted significant funding, and it is now intended to complete restoration of the headframe and fan house.

SOURCE: ANON, 2019, Good progress at Hetty Pitt. *Industrial Archaeology News* 189, page 7.

A new use for abandoned deep coal mines

The Glasgow Geoenergy Observatory currently under development at the eastern end of the city is to investigate the extraction of heat from abandoned deep coal seams. There are five or six levels of worked seams below the site, and associated mine shafts, down to a depth of about 175 metres, created during the years 1820 to 1934. These are now largely flooded, containing water at a temperature of from 12 to 20 degrees Celsius.

The mine shafts have generally been backfilled with mine waste (often referred to by the ignorant as 'slag' heaps) and the galleries are deformed by collapses. The mined-out areas are largely filled by mine waste (goaf). However all this waste contains a multitude of interconnected voids which act as a reservoir for the mine water, and a medium through which it can readily flow. Calculations of mine voids based on abandonment plans suggest that 50% of the voids created by pillar-and-stall mining remains within the below-ground waste, and 20% in mines worked by the longwall method.

Twelve boreholes are being made to allow colder water to be forced into them and the warmer water pumped up. Water yields and temperatures and chemical properties will be monitored. The temperature can be boosted using heat pumps, and the water used for space heating. Technical problems to be overcome include the avoidance of the associated pipework being blocked by ochre (hydrated iron oxide) being deposited in them. Iron pyrites (iron II sulphide) in the abandoned mine waste is converted by water and dissolved atmospheric oxygen to iron sulphate in solution in the retrieved mine water. This in further contact with air is then oxidised to insoluble ochre, and the mine water is then rendered acidic.

If this heat extraction process proves to be economically feasible there is considerable scope for deep coal mines again being a significant energy source. It is estimated that 25% of British homes lie above coalfields. The magnitude of the resource can be imagined by the volume of mined voids in these areas. It is estimated that if all the coal mined nationally was spread over the land surface of the British Isles it would form a layer five centimetres thick. There is already an operational district heating scheme for 150 homes at Bridgend in Wales. An alternative or complementary energy source from old coal mines already exploited is methane tapped from them.



Currently there is also operational geothermal energy exploitation at Southampton, where the general geothermal gradient rather than mine water is the source. The Glasgow observatory is a collaboration between the University of Durham Energy Institute and the British Geothermal Research Partnership.

SOURCE: ADAMS, Charlotte, Alison MONAGHAN, and Jon GLUYAS, 2019, Mining for heat. *Geoscientist* 29(4), 10–15.

Russian oligarch bids to purchase former Drakelands tungsten mine in Devon

Back in October the collapse of the Drakelands tungsten mine project (formerly known as Hemerdon Mine or the Hemerdon Ball or Hemerdon Bal Mine) close to Plymouth was announced. Operator Wolf Minerals was no longer able to furnish its massive debts with production falling below expectations and tungsten prices falling. Now it seems that a wealthy Russian oligarch may be looking to buy the failed concern. At the end of November reports circulating in the local media suggested that Vladimir Lorio, one of the world's richest men, might be interested in pumping £25 million into reviving the mine through his company Pala Investments.



Drakelands Mine in happier times

£25 million is considered to be a very conservative figure by mining experts to restart production at the site which is currently mothballed. The Russian is reported to have deposited £14 million in an account for this project and has been in talks about his plans. Talks may have stalled on the cost of restoring the land after mining has finished, a key local demand for local planners. There are also thought to be problems with a trio of banks, all creditors of the former Wolf Minerals. At least two other companies are interested in restarting production, but they put the cost at a much higher figure, around £40 million. SOURCE: *Down to Earth extra* (the journal of GEO Supplies), no 73, January 2019.

Good news for the Institute of Mining & Mechanical Engineers, Newcastle-upon-Tyne

Members who attended our Study Weekend at Newcastle-upon-Tyne some years back will recall that we met at the splendid Victorian tiered lecture theatre and library of the

North of England Institute of Mining and Mechanical Engineers, a short walk from the central railway station. The neo-Gothic Institute and building dating from 1872, and its contents, have been at risk in the harsh financial climate of recent years. But it has now received a National Lottery Heritage Fund grant of £4.1m, to be applied to conservation of the structure and digitisation of the important archives, matched funding having been secured. The establishment is to be reformed as 'The Common Room'. The building is at present closed for conservation, and due to reopen in autumn 2020. www.thecommonroom.org.uk/brochure.pdf

SOURCE: North of England Institute of Mining and Mechanical Engineers 2019. Good news for NoEIMME. *Railway and Canal Historical Society Early Railways Group Members' Circular* 36 (March 2019), page 1.

Welsh Gold Revival?

There have been a number of press releases lately from Alba Mineral Resources, which have a 90% stake in Gold Mines of Wales Limited (GMOW), claiming that there is a 'lot of gold' remaining at Clogau gold mine, but the challenge is accessing it. They claim that "significant" reserves are believed to have been discovered across a wide area in the Dolgellau Gold Belt.



Clogau, near Bontddu, was the UK's largest historical gold producer with the last gold mined from the site in 1998. Work is supposed to have started on the upper level and to reinstate the shaft between this and the lower level. During the summer, bulk sampling and drilling will take place in Llechfraith Adit to uncover the rich seams of gold that Alba believe are lurking in the mine. Exploration work at the mine is being carried out under existing permissions but Alba is submitting their pre-application enquiries to planning authorities at Snowdonia National Park Authority.

SOURCE: *Below*, the journal of the Shropshire Caving & Mining Club, Summer 2019.

Gwynfynydd gold mine to restart mining

There has been activity on the surface at Gwynfynydd gold mine which was purchased by Bodolwyddan-based Clogau Gold of Wales Ltd in 2016. They previously worked Clogau gold mine but gave it up as it was too difficult to work. They claim that they don't need to work

Gwynfynydd on a full commercial basis, they only need small amounts to use in their jewellery. Unlike other mines in the area where the gold was found in shallow deposits, the Gwynfynydd gold was extracted from large quartz veins deep underground.



Underground mill at Gwynfynydd

An application has been submitted to the Crown Estate to commence mining and they are awaiting a decision. However the application would also need the approval of Natural Resources Wales.

SOURCE: *Below*, the journal of the Shropshire Caving & Mining Club, Summer 2019.

Nenthead mines alert, Cumbria

Intending visitors to the popular mines exploration area at Nenthead near Alston, Cumbria, have been alerted to a popular underground route rendered impassable by a roof fall. The route is that from Smallcleugh to the Hangingshaw area of Rampgill. Local mine explorers are currently attempting to clear a safe route. Those abseiling on the usual route at Proud's Sump are advised not to pull down the ropes as there is no other way back.

SOURCE: JONES, Chris, 2019, Nenthead warning. *Descent* 268, page 16.

Cornish Lithium secures additional funding

Cornish Lithium, a start-up company hoping to lead the development of an industry for the battery metal in the UK, has secured a further £1 million from its existing investors, which will allow the firm to expand its ongoing drilling work in the ancient mining region of Cornwall. A year ago, the company said it needed about £5 million to develop its project, which aims at extracting lithium from hot water brines below the surface that have welled up in the county's historic tin and copper mines.

Former mines, such as South Crofty, could be revived. The company will also begin exploring for lithium in hard rock form for the first time, having discovered evidence that it was mined in the area during World War II. Lithium-bearing veins have been discovered in South Crofty mine, near Redruth.

Over the past year, the company has expanded and consolidated the areas over which it has rights to explore for lithium and other minerals. The company says its team has assembled a vast amount of historical data and reconstructed this in 3D digital format, enabling a



Former mines, such as South Crofty, shown here, could be revived. Photo Nick Catford

totally new understanding of the geological potential of Cornwall's mineral deposits.

SOURCE: *Down to earth* (the journal of GEO Supplies), no 74, Feb 2019.

Access to a Derbyshire sough now reopened

Access, subject to terms and conditions, has now been reopened to Peakshole Sough, a mine drainage tunnel driven westwards under the footpath in Peaks Cavern Gorge. The narrow tunnel, of which a photograph is included in the cited source, leads to a 'small set of interesting and historically important' mine workings. For access contact the Peak Cavern keyholders via www.peakspeedwell.info or Email peakaccess@peakspeedwell.info giving your choice of date and group details.

SOURCE: WOLSTENHOLME, Phil, 2019, Peakshole Sough access. *Descent* 268, page 15.



Peakshole sough. Photo Ashley Dace



Steam pumping and winding engines at mines in England

Mining was restricted to shallow depths in high ground before the introduction of steam-powered engines to pump out accumulated ground-water. Monumental winding engine houses are often the sole surviving visible surface features of coal and metalliferous mines, and the foundations of others which have now been demolished remain accessible to archaeological excavations. As novel features in 18th-century landscapes, engine houses often feature in landscape artists' work. Beneath these relics there are of course effectively indestructible mine shafts and galleries.

A recent issue of the Newcomen Society's journal is devoted to papers about historic steam engines at mines in the Black Country, Derbyshire, Lancashire, South Yorkshire and Tyneside. Some of the important historic engines are now at a museum in the USA, collected by the millionaire car manufacturer Henry Ford in 1928.

SOURCES: BARNATT, John, 2018, Investigating the 1794–95 Newcomen-type pumping engine at Watergrove mine, Derbyshire. *International Journal History of Engineering and Technology* 88(1), 57–72 [Lead mine]; GREENER, James, 2018, The first and third engines. *International Journal History of Engineering and Technology* 88(1), 80–111; GRUDGINGS, Steve, 2018, Old Sarah – a late survivor. *International Journal History of Engineering and Technology* 88(1), 124–134; KITCHING, David, 2018, Hidden in plain sight – Nathaniel Wright's pirate engine house.

International Journal History of Engineering and Technology 88(1), 73–79 [Norbury Colliery, Stockport]; HUNTER, John, 2018, Newcomen-type pumping engines in collieries and ironworks on the north side of the Don valley in the Rotherham area of South Yorkshire in the eighteenth century. *International Journal History of Engineering and Technology* 88(1), 1–36; POINTON, Ken, and Andre POINTON, 2018, Building a 21st-century Newcomen engine. *International Journal History of Engineering and Technology* 88(1), 135–163; TURNBULL, Les, 2018, William Brown's giant Tyneside engines. *International Journal History of Engineering and Technology* 88(1), 112–123.

Underground and mainstream archaeology

Mainstream archaeologists have long steered clear of engaging with the archaeology of subterranean sites. This imbalance in British archaeological research reflects the practicalities and costs of access, as is also the case with submarine access to shipwrecks, and aerial archaeology. A notable exception is the work on the prehistoric flint mines at Grimes Graves in Norfolk, where William Greenwell, followed by many others, has done important work in mining archaeology from about 1870 onwards. Another problem has long been the gullibility of archaeologists, especially those of the antiquarian era.

W.J. Nichols' papers on the 'Caves' published in the *Journal of the British Archaeological Association* in 1903 and 1904, where they are said to be of Druid, Roman and Saxon age, constitute a fine example. They are in fact largely early modern chalk mines.

From about the 1950s onwards, valuable exploration and recording work has been done by members of caving clubs and mining history societies. Sadly, much excellent work has been published only in relatively ephemeral club magazines, often not found in libraries.

The published work of former SubBrit Honorary Member the late Harry Pearman, and of the Kent Underground Research Group, is more widely available and known. The Kent group, indeed, operates as a group of the Kent Archaeological Society, with some of its reports published in the major journal *Archaeologia Cantiana*. Beyond the southeast, some of the most important mining archaeology and history has been published in the long-established major journals of the Northern Mines Research Society and the Peak District Mines Historical Society, although there is a strong bias towards lead mining.

The place of mining as an important recognised branch of academically sound archaeology has now been made clear to the wider archaeological community by the publication by Historic England's book. *The archaeology of underground mines and quarries in England* constitutes an important advance. This work has been awarded the Peter Neaverson Award for Outstanding Scholarship by the Association for Industrial Archaeology.

John Barnatt's book is the subject of an eight-page illustrated review in *Current Archaeology* 30(4) (352), 42–49 (July 2019).

SOURCES: BARNATT, John, 1999, *The archaeology of underground mines and quarries in England*. Historic England: (4) + 136pp. ISBN 978-1-84802-381-9.

CATLING, Chris, 2019, Going underground: unearthing the archaeology of England's mines. *Current Archaeology* 30(4) (352), 42–49.

Symposium on Scottish mining

A symposium is being held on 19 October 2019 at Leadhills, South Lanarkshire. The topic is "Mining history and archaeology in Scotland: towards a research strategy", and this will be a one-day conference organised by Leadhills Heritage Trust and Historic Environment Scotland.

The venue is Arms Hotel, Leadhills, South Lanarkshire and the conference will run from 10:30 to 15:30. Speakers include Dr John Crawford, Leadhills Heritage Trust; Dr Peter Cloughton, National Association of Mining History Organisations; Dr Miles Oglethorpe, Historic Environment Scotland; Dr Catherine Mills, University of Stirling; John Pickin, independent researcher; and Ken Ledger, Leadhills Heritage Trust. For further information contact leadhillsconf@outlook.com.

SOURCE: Mike Moore.



Nymfes underground marble quarry, Paros, Greece

The island of Paros, about 90 nautical miles southeast of Athens, was the source of the sought-after Parian marble, quarried for architectural purposes and sculpture from 3,200 BC. The underground quarries featured in this study include two main quarry tunnels up to 190 metres long, and side tunnels, with floor to ceiling heights of up to four metres. The report includes location maps, a schematic quarry plan, and sub-surface photographs.



The entrance of the western gallery of Nymfes Quarry. The widened excavated area encountered at 20 m from the tunnel entrance can be seen

SOURCE: MARINOS, Vassilis, *et al.*, 2019, 3D modelling of the ancient underground quarries of the famous Parian marble in the Aegean Sea, Greece, and assessment of their stability using LIDAR scanning. *Quarterly Journal of Engineering Geology and Hydrogeology* 52(1), 61–73.

New deep coal mine approved near Whitehaven, Cumbria

Cumbria County Council has granted planning permission to West Cumbria Mining Ltd for a new deep mine for coal from reserves near Whitehaven. Due to commence production in two years time, the mine would employ 500 people and supply steel furnaces, in the place of fuel currently imported from Canada, Colombia and Russia. Deep mining for coal in the UK ended in December 2015 when Kellingley colliery in North Yorkshire closed. The Council's decision has been opposed by campaigners for a reduction in fossil fuel consumption and consequent climate change.

SOURCE: INMAN, Phillip, 2019, First new deep coal mine for 30 years gets go-ahead. *The Guardian*, 20 March 2019, page 2.

NEWS - MISCELLANEOUS

Subterranean gas and oil storage, UK

Whereas canal and railway tunnels and London Underground, and now Cold War bunkers and World War II air-raid shelters, are the well-known man-made structures underground, there are many other artificial voids in the UK which are not. Creating, operating and decommissioning these artificial 'caverns' has employed many engineering geologists. A recent paper provides

details of fuel storage caverns at Canvey Island in Essex and at the island of Portland in Dorset.

At Canvey Island four large refrigerated underground tanks created in the 1960s were to store 21,300 tonnes of liquefied natural gas. These have now been decommissioned and back-filled with sand dredged from the Thames. The design of 14 deep gas-storage caverns on Portland by solution of halite beds in the Kimmeridge Clay had to take account of landslide records from 1615 onwards.

SOURCE: PRIVETT, Kevin D., 2019, The lines of evidence approach to challenges faced in engineering geological practice. *Quarterly Journal of Engineering Geology and Hydrogeology* 52(2), 141–172.

Cheese stored underground in Switzerland

For many shoppers who browse the cheese aisle at their local grocer's, the little wedges of Emmi Le Gruyère, in their translucent wrappers with the blue company logo and the Swiss cross at the top, are hard to miss. But few buyers know that the cheese is meticulously aged at the Kaltbach Cave, a tunnel-like cave within the Santenberg mountain with climatic conditions that are just right for ripening cheese. The cool subterranean labyrinth of the Kaltbach Cave is the natural incubator for 156,000 wheels of cheese, mostly gruyère and emmentaler.

Stretching over a mile, stacked shelves hold the cheeses at temperatures around 50 degrees Fahrenheit year-round, and the cool waters of the river that runs through the cave keep humidity levels at around 96 percent. The cave's unique climate and the interaction of mineral deposits on the sandstone with the cheese create a distinctive flavour and aroma, and give the rinds their signature dark brown colour.



The wheels of cheese are turned, washed, and brushed with a brine solution every 7 to 10 days. The cheeses stay in the cave for at least nine months, diligently monitored until they reach just the right aromatic and textural maturity. The art of caring for and gauging the maturity of cheese is called cheese refinement, and it's a skill transferred down through generations of cave masters at Kaltbach.

The cave was discovered in 1953 as a natural cheese-ageing habitat when local cheesemakers ran out of storage space and began keeping them in the Kaltbach. In 1993, Emmi acquired the cave and has been storing and ageing their finest cheeses in it since. The contribution of this tranquil cave in a Swiss mountain to the cheese boards of the world should go unnoticed no more. Emmi organizes tours of the cave. You can find more information on their website.

www.emmi-kaltbach.com/en/international/homepage

SOURCE: *Atlas Obscura*..

Subterranean compressed air storage, UK

With the steep decline in mined coal combustion, and the prospect of a similar decline in reliance on burning hydrocarbons for energy generation there is intensive development of more sustainable ways of generating electricity. Whereas coal and hydrocarbons can be stored in great quantities, from a practical and economic point of view electricity cannot. Electricity generated by solar or wind power has to be used as soon as produced, and of course neither sunshine nor wind is constantly available. The use of sustainable energy is increasingly dependent on pumped storage schemes such as at Dinorwig in North Wales. Electricity however generated is used to pump water to a high-level reservoir when domestic demand is low, and the water allowed to flow back down through conventional hydro-electric power plant to meet peak demand. This approach is of course most practicable in mountainous terrain. In lowland areas, the potential energy stored in compressed air offers a similar solution. The air can be stored in artificial caverns made by using water to dissolve huge cavities in rock-salt beds deep underground. Ways to control the shape and size of the voids are explored in the cited source.

SOURCE: FIELD, C. Paul, *et al.*, 2019, Determining constraints imposed by salt fabrics on the morphology of solution-mined energy storage cavities. *Quarterly Journal of Engineering Geology and Hydrogeology* 52(52), 240–254.

House of Vans in tunnels beneath London’s Waterloo station



Photo Clive Penfold

Opened in the summer of 2014, The House of Vans is the second of its kind after the success of the original opening in Brooklyn, New York in 2010. Not only does it play host to London’s first and only indoor skatepark but laid out over five previously disused tunnels are an art gallery, cinema, live music venue and a premium cafe and bars. The idea behind this 33,000 sq ft indoor space is to fuel creative expression and engage with the local community with the Vans ‘Off The Wall’ spirit, and in tunnels 4 & 5 lie the designated skate areas. The packed programme of events is almost always entirely free.

Website <https://houseofvanslondon.com/>

SOURCE: Skateparks Project website.

Hidden London exhibition at London Transport Museum, from 11 October 2019

An underground aircraft factory on the Central line and Churchill’s secret shelter in a bomb-proof tube station are some of the secrets of the tube revealed in an upcoming exhibition.

Hidden London at the London Transport Museum delves into some of the lesser-known and forgotten parts of the tube network, and how they were used in the Second World War. It turns out the tunnels were quite useful in wartime, sheltering Londoners during air raids, and even housing the Plessey underground aircraft factory, which employed 2,000 members of staff (mostly women) in 2.5 miles of tunnels on the Central line.

Churchill himself took shelter in the Railway Executive Committee’s bomb-proof headquarters deep underground at Down Street station. His secret subterranean dining room – where he was regularly served caviar and champagne – is realistically recreated in the exhibition, as is the old Aldwych station ticket booth, offering an excellent chance to ogle some (imitation) Leslie Green tiles.



Plessey factory located in unopened Central line tunnels in 1941

Further highlights guaranteed to make any tube fan swoon include a display of vintage tube posters, and decorative tiles taken from disused stations. Film posters from productions which were shot in abandoned stations, including *Skyfall*, are on show too. As well as looking at



how these quirky parts of the tube have been used, you can find out why they came about in the first place. Rare vintage photos, and secret diagrams are used to explain the social, economic and political factors that led to the spaces being abandoned.

The exhibition launches at a museum late, with a pop-up bar, music, a scavenger hunt, and a London-based quiz. The exhibition opens on 11 October 2019.

SOURCE: London Transport Museum

MoD nuclear bunker brought into use, Whitehall, London

The Ministry of Defence Cold War-era bunker below Whitehall has been brought into use to ‘provide Army support’ to be deployed if needed in the event of a ‘no deal’ UK departure from the European Union. Plans are being made to cope with severe traffic congestion in Kent as a result of prolonged border checks at Calais and Dover, where 11,000 lorries pass through each day, some on ferries and some conveyed on shuttle trains through the Channel Tunnel. Food and fuel supplies could be disrupted. Delayed goods vehicles may be directed to provision for emergency parking on motorways and airfields. Some 3,500 MoD personnel may be available to assist with facilitating food and fuel distribution, and, if needed, to ‘handle rioting’.



Photo David Moore

Kent County Council is considering the possible impact on everything from school buses to ambulances and refuse collection, as well as massive air pollution by delayed traffic. The Whitehall bunker was, reportedly, last used in connection with security and logistics planning for the London Olympic Games 2012, and for flood-relief planning.

SOURCES: RADNEDGE, Aidan, No-deal Brexit bunker at MoD. *Metro*, 22 March 2019, pages 1 & 4; O’CARROL and Richard ADAMS, No-deal Brexit could leave pupils stranded in schools. *Guardian*, 22 March 2019, page 10.

Williamson’s Tunnels win prestigious Hidden Gem award

The Liverpool City Region’s best tourism events, attractions and venues were celebrated on 16 May at a prestigious awards ceremony at Liverpool Cathedral. A total of 19 accolades were handed out as the cathedral played host to the Liverpool City Region Tourism Awards 2019.



Chairman Gordon Hunter and Trustee Chris Iles receiving the award on behalf of FoWT from Andi Oliver

Television presenter, ‘Great British Menu’ judge and ‘Saturday Kitchen’ presenter Andi Oliver introduced the event, which recognised the area’s top eateries, exhibitions, hotels, event spaces and tourism attractions. A *Hidden Gem* category to highlight the region’s ‘best kept secret’ was voted for by the public this year, with Friends of Williamson’s Tunnels picking up the prize from a shortlist of ten. The award was presented to FoWT Chairman Gordon Hunter and Trustee Chris Iles by Andi Oliver.

SOURCE: *YM Liverpool* , 17 May 2019.

The origin of ground emissions of methane: coal seams or landfill?

Methane (CH₄) has long been a matter of public interest and concern. Historically, methane gas emanating from coal seams was the prime suspect in explosions in coal mines, a view only a little modified when it was realised that air laden with coal dust was another cause. Currently, public interest in this odourless gas and other fossil fuels concerns the production by combustion of carbon dioxide and its role in climate change. Methane, apart from that given off by coal seams, is also a product of rotting organic matter.

At 6.30 am on 24 March 1986 a bungalow at 51 Clarke Avenue, Loscoe, ten miles north of Derby, was completely destroyed by a methane explosion. Three occupants were badly injured. At the ensuing public inquiry the origin of the gas was considered. There are abandoned coal seams at shallow depth below Loscoe, as well as a landfilled clay pit seventy metres from the site of the bungalow.

SOURCES: TEASDALE, Christopher J., Jean A. HALL, John P. MARTIN, and David A.C. MANNING, 2019, Discriminating methane sources in ground gas emissions in NW England. *Quarterly Journal of*



Engineering Geology and Hydrogeology 52(1), 110–122.
WILLIAMS, G.M., and N. AITKENHEAD, 1991,
Lessons from Loscoe: the uncontrolled migration of
landfill gas. *Quarterly Journal of Engineering Geology*
24(2), 191–207.

North Wales farmer blocks access to popular tourist location

Sheep farmer Allan Titley used a digger to block the tunnel access to Blue Lake, a spectacular flooded quarry, in Gwynedd, North Wales. He moved 60 tons of slate to seal off the mine workings which allow access to the lake, near the coastal village of Fairbourne, and hopes it will now become a nature reserve.

Mr Titley, 70, who bought his 500-acre farm in the 1980s, had previously allowed visitors access to the lake. The beauty spot is on private land and there is no right of way to it. But he said the litter problem has become substantially worse due to publicity about the ‘secret’ site on social media. Hundreds of visitors have flocked to swim or camp at the lake on summer weekends.

Mr Titley said although some tourists were responsible and picked up litter, it was mostly left to himself and local volunteers. They were faced with a never-ending mess of abandoned barbecues, camping paraphernalia and even used condoms and human excrement. Bags of dog mess were put in bags but then tied to trees.

A letter from the local council earlier this year threatening to prosecute him for fly tipping over the rubbish proved the final straw. The council sent Mr Titley the notice because he, as landowner, is deemed legally responsible for rubbish at the site.

SOURCE: *MailOnline* 27 May 2019

Pope’s Grotto public open days, Twickenham, London

The grotto constructed for satirical poet Alexander Pope (1688–1744) in Twickenham in 1719 is currently being restored and mineral specimens on the walls replaced. The site, a tunnel below a school, will be open to the public during the Twickenham Festival in June 2019, and during the London Open House weekend in September.

SOURCE: Pope’s Grotto Trust, 2019, Pope’s Grotto. *London Archaeologist* 15(8), page 244.



London Metropolitan Archives exhibition on underground London

From lost rivers to underground railways, deep shelters to sewers, the sprawling network of tunnels and spaces under London are a subject of fascination and fear. They support our life on the surface, keeping us moving and providing essential services, and yet we know comparatively little about the extent or depth of the city that lies beneath us.

Under Ground London at London Metropolitan Archives will explore our relationship with the subterranean capital, exploring hundreds of years of documents, images and plans to tell the story of the underground city, as well as some of the enduring legends that have risen from the darkness down below.

Celebrating the 200th anniversary of the birth of one of London’s less celebrated heroes, Sir Joseph Bazalgette, the exhibition will uncover the system of sewers he designed to save London from the Great Stink. It will explore the first tunnel under the Thames, the development of the first ‘underground’ railway and the first tube line, which might not be quite what you expect.



Joseph Bazalgette (top right) at the northern outfall sewer being built below London’s Abbey Mills pumping station.
Photo Otto Herschan

Under Ground London will dig into the collections at LMA and reveal what lies beneath the capital, presenting original documents, maps, images and films which record the development of, and our relationship with, the subterranean city.

London Metropolitan Archives are at 40 Northampton Road, Farringdon, London EC1R 0HB. The LMA is open Monday – Thursday and Saturday from 09.30. The exhibition runs until 30 October 2019.

SOURCE: London Metropolitan Archives website

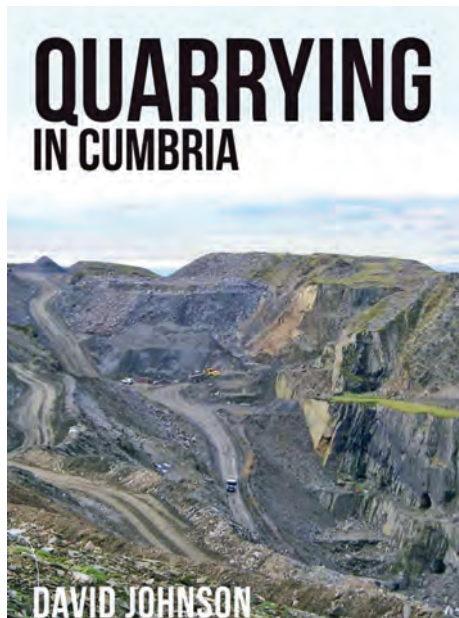
NEWS - PUBLICATIONS

Opencast and subterranean quarries, Cumbria

DETAILS: JOHNSON, David, 2018, *Quarrying in Cumbria*. Stroud: Amberley Publishing: 96pp [ISBN 978-1-4456-7246-5]

David Johnson has a well-established track record in both academic and more ‘popular’ published work on the mineral industries, and especially lime-burning, in northern England. Although *Quarrying in Cumbria*





is at first sight little more than a book of photographs and captions, it is highly recommended as a carefully researched and reliable overview of the geology and extractive industries of the Lake District and Cumbrian coastal plain. In a three-page introduction the scope of the book is outlined, and the various popular and legal uses over time of the word 'quarry' are discussed. The meaning of 'quarry' as defined in the 1954 *Mines and Quarries Act* has been used in the text.

Preliminary pages deal with Neolithic hand-axe quarries and stone sources for Hadrian's Wall, followed by chapters on slate, limestone, sandstone, gypsum, clay, mudstone and sand. Of these, slate and gypsum have been worked underground. The former deep coal mines between Maryport and Whitehaven are not considered, nor are the still-active deep gypsum mines to the east of the district.

There are one or two illustrations on almost every page, mostly of surface structures and landscapes, with generous and well-informed captions. Most of the photographs are coloured, with some monochrome historic ones. About eight depict tunnel entrances, and there are only two underground views. Concluding chapters deal with quarrying machinery and processing plant, and related transport infrastructure. Current uses of abandoned quarries are briefly noted, with two pages on further reading and sources, and an index of sites.

World War II secret sites in the UK

DETAILS; PHILPOTT, Colin, 2018, *Secret wartime Britain: hidden places that helped win the Second World War*. Barnsley: Pen & Sword Books Ltd: xx + 247 pp [ISBN 978-1-52673-547-8]

During World War II some thousands of new buildings and structures were erected, of which many including domestic and public air-raid shelters, 'British' or 'Civic' restaurants, and new airfields and associated buildings, became of course familiar sights to the British public.

Other war-related purposes were accommodated in new or adapted existing buildings, or by the reuse of pre-



existing mines and tunnels. This book reviews the whole field of non-public war-related sites, the great majority of which were above-ground existing buildings. Their wartime purposes included command centres, spying and listening posts, broadcasting and propaganda, decoys, post-invasion resistance facilities, prisoner-of-war camps and internment and interrogation centres, art treasures and museums stores, and munitions stores and nuclear weapons development sites.

A few of the sites covered were not in fact secret, such as the Victoria tunnel public air-raid shelter at Newcastle-upon-Tyne, the Chislehurst 'caves' and the London Underground and associated deep-level tube shelters.

The locations of the underground sites will probably be familiar to most Subterranea Britannica members, who may be disappointed by the lack of detail for specific locations. Indeed, the fullest accounts are for places about which much more has already been published elsewhere, and some of which are now publicly accessible.

Three pages are devoted to listing sources including national and other archives, published books and articles, and websites including our own. There is an index occupying eleven pages which might have been compiled with more care. For example, RAF Fauld appears as RAF Fold, and RAF Chilmark is listed as Childmark. The help of Nick Catford and Bill Ridgeway of Sub Brit and our website is acknowledged. Overall this volume provides a useful overview of sites, and of their planning, purposes and operation.

Cave church at the Monastery of St Paul, Egypt

DETAILS: LYSTER, William (ed), 2008, *The cave church of Paul the Hermit at the Monastery of St. Paul, Egypt*. Yale University Press: xx + 395pp [ISBN 9780-300-11847-8]

This is a sumptuously illustrated hardback volume reporting the conservation of numerous wall paintings in an enlarged natural cave which formed the nucleus of an isolated Christian monastery in a cliff face in the

northeastern part of the Galala Plateau between the Nile / Eastern Desert and the Gulf of Suez in Egypt. The cave was reportedly the home of an early, if not the first, Christian hermit in the fourth century CE.

The cave was enlarged by making rock-cut rooms, and by the 13th century had become a subterranean church. It was further extended in the 18th century, and external extensions added. The elaborated and extended cave now lies within one of the world's oldest functioning Christian monasteries, consisting of a complex of later surface buildings. Despite its remote location it can now be reached by a motor road, and is visited by tourists.

Archaeological features are well reported, alongside copious colour photographs of the 13th- and 18th-century wall paintings as well as archaeological and architectural plans and elevations. There are also numerous photographs of the monastery's surface buildings, and the arid landscape within which they are set. The location owes its development to a spring fed by occasional rainfall on the limestone plateau, the highest part of which is over 1,400 metres above sea level.

Kent's industrial heritage

DETAILS: PRESTON, James, 2016, *Kent's industrial heritage*. Stroud: Amberley Publishing: 96pp [ISBN 978-1-4456-6216-9]

Jim Preston has been known as a respected historian of industry in Kent since publication in 1977 of his book *Industrial Medway: an historical survey*. The industrial development of the lower Medway valley with special reference to the nineteenth and early twentieth centuries is based on his 1976 MA thesis. That volume dealt *inter alia* with brick making, cement and lime manufacture, copperas, fullers' earth, and sea-salt. It did not however note that chalk, fullers' earth, and to a small extent Kentish Rag building-stone have all been mined underground in the district. The mining of fullers' earth remains to be researched, although there is some published information on subterranean chalk and ragstone extraction.

The present volume is essentially a compendium of colour photographs and extended captions featuring generally surviving and accessible buildings and structures being relics of a wide range of industries. The only underground workings noticed are the former east Kent collieries, to which three pages including three photographs of surface buildings are devoted. There is a useful two-page bibliography and list of websites.

Kent's transport heritage

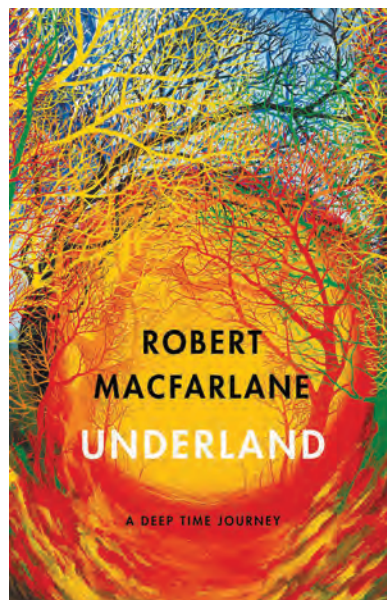
DETAILS: PRESTON, James, 2017, *Kent's transport heritage*. Stroud: Amberley Publishing: 96pp [ISBN 978-1-4456-6991-5]

This book is essentially a compendium of colour photographs generally of surviving and accessible buildings and structures of historic interest related to road, rail, water and air transport in Kent, with accompanying captions. Only two tunnels are featured, the Lydden

rail tunnel near Shepherdswell Station on the line from Canterbury to Dover, and the Strood & Higham canal tunnel opened in 1824, but shortly afterwards converted to railway use.

There is no mention of the Channel Tunnel, the Dartford Tunnel, the Shakespeare Cliff Tunnel, and many others. With limitations, it is a useful if partial overview of items from milestones and bridges to railway signal boxes and airports. There is a useful two-page bibliography and list of websites.

Underland



DETAILS: MACFARLANE, Robert, 2019, *Underland: a deep time journey*. London: Hamish Hamilton / Penguin / Random House: viii + 488pp [ISBN 9780-241-14380-3] £ 20.

This is a successfully ambitious and thought-provoking book surveying the human species' interaction with the only habitable planet known to them. A recurring theme is our responsibility for the perceived need to recognise a new geological era, the Anthropocene, characterised by significant changes to the earth's crust which will remain long after *Homo sapiens* has joined the trilobites, ammonites, dinosaurs and other extinct species.

Will mankind be recognisable to future generations as a 'good ancestor'? Proposed start points for the Anthropocene range from man's use of fire via the Industrial Revolution to the nuclear age. Currently, the widespread use of virtually indestructible plastics is leaving discarded polythene worldwide. After the Stone, Bronze, and Iron Ages now perhaps we have the Polythene Age.

Macfarlane's time and world tour commences with Bronze Age burial chambers on the Mendip Hills in Somerset and ends in a deep nuclear-waste depository under construction in Finland.

At least two locations included will be familiar to Subterranea Britannica members who have visited them: the Boulby potash mine on the Yorkshire coast and some

miles out below the North Sea, and the ‘catacombs’ and quarry tunnels under Paris. The Boulby account includes the ‘dark matter’ laboratory (which we have not visited) as well as the spectacularly extensive mine workings.

Perhaps of greatest interest to most members is the visit to a deep nuclear-waste repository under construction at Olkiluoto Island in southwest Finland. Here there is a public visitor centre to explain how this facility is designed to keep high-level nuclear waste secure to outlive its designers, the species *Homo sapiens* itself.

Although most chapters deal with underground spaces made or used by *Homo sapiens*, there are also sections featuring the entirely natural world, such as limestone caves in Slovenia and the immensely extensive interconnected masses of fungal hyphae in forest soils and their mutually beneficial connections to tree roots. The largest living organism on our planet is thought to be a honey fungus found in the Blue Mountains in Oregon, two and a half miles across, inhabiting almost four square miles of forest soil.

The book reveals little about the author who is, we are told, 41 years old with a youngest son aged four. Intriguingly his earlier books include *Mountains of the Mind*, *The Wild Places*, *The Old Ways*, *Landmarks*, and *The Gifts of Reading*. The book has 19 pages of detailed supplementary notes, a 21-page bibliography, and a 19-page index.

NEWS - TUNNELS AND TUNNELLING

Fortieth anniversary of the Jubilee line, London

The London Underground’s Jubilee line, the most recently constructed, opened in 1979, forty years ago, although what is now its northern end, from Baker Street to Stanmore, is in fact an absorbed length of the earlier Metropolitan line. In 1939 the Stanmore branch of the Metropolitan was transferred to the Bakerloo line, so a trip from Baker Street to Stanmore is a ride through underground history. New platforms and tunnels in 1979 at Baker Street accommodated southbound trains to Bond Street and a new subsurface terminus at Charing Cross. The new line was extended to Stratford in east London, so the Jubilee line added two further Thames tunnels for London. The new line also added further stretches of abandoned tube train tunnels, as Charing Cross where there was a reversing loop at the southern terminus was by-passed, the new alignment being from Green Park via Westminster to Waterloo and beyond.

The new Westminster platforms are London’s deepest, being 105 feet below sea level (and, yes, London Underground planners took the flooding risk posed by the Thames into account). The Jubilee line was at first to have been called the Fleet line, but was opened on 30 April 1979 as the Jubilee line to celebrate the Silver Jubilee of Queen Elizabeth II. Her son Prince Charles drove the first service train into the closed Charing Cross platforms which now see occasional use as a film set.



*The Jubilee line terminus at Charing Cross (now closed).
Photo Nick Catford*

SOURCE: Happy birthday to the Jubilee line, *Metro*, 1 May 2019, page 37.

Defiant landowner says he will block infilling of Queensbury railway tunnel

Landowner David Sunderland has waded into the long-running battle to save the tunnel from abandonment. Nearly 3,500 objections have been left on Bradford Council’s planning website in response to Highways England’s application to infill the tunnel.

The campaign against the plans has been galvanised by the Queensbury Tunnel Society, which says there is a “now-or-never opportunity” to transform it as part of a Bradford-Halifax greenway. Mr Sunderland has spoken out, saying he will not co-operate with any works to abandon the tunnel.



David Sunderland in the flooded cutting leading to the southern portal

In his objection to the application, Mr Sunderland claims: “I own the land and former railway cutting at the south end of Queensbury Tunnel, right up to the tunnel portal. The applicant has indicated its intention to use my land as an access route into tunnel and reach shaft No. 1, as well as establishing a works compound on it. I will not cooperate with any works to abandon Queensbury Tunnel. It is an important and valuable public asset and should be listed and preserved so that future generations can benefit from its many attributes.”



In response to Mr Sunderland a spokesperson for Highways England said: “The tunnel needs to be closed to reduce the risk to the community around Queensbury Tunnel.”

Source: *Bradford Telegraph and Argus*, 13 July 2018.

New deep-level electricity cable tunnel, London

A new 8.5 kilometre deep-level cable tunnel under London is due to be completed in the summer of 2019. At depths of from 22 to 30 metres the tunnel will accommodate power cables to supply the rapidly developing Battersea Power Station and Nine Elms residential area, as well as the American Embassy.

SOURCE: BLUNDEN, Mark, 2019. Top secret super-tunnel delivers power to US embassy, *Evening Standard*, 26 March 2019, page 33.

Three sewers blocked by concrete, north London

Thames Water is all too familiar with ‘fatbergs’, congealed masses of sewage stuck together with waste cooking fats and oils poured down the drains by the likes of ‘takeaway’ food establishments. These block sewers and are unpleasant and expensive to clear. A new addition to the English vocabulary has now been established for an equivalent blockage composed of set concrete.

It appears that persons working for contractors at a site at the junction of Goswell Road and Hall Street near City University in Islington disposed of a large quantity of cement surplus to requirements by pouring it down a street drain. The result is a 100-metre-long rock-hard blockage affecting three sewers. Pneumatic drills, jackhammers, and high pressure water jets are to be employed in the confined space to clear the concrete which has part filled the sewer, adhering to the brick walls.



Concreteberg at the junction of Goswell Road and Hall Street, Islington

Thames Water estimate this will cost them (so their customers) up to a million pounds to remove. This will take about two months during which time there will necessarily be road closures and sewage removal tankers to prevent flooding by matter backing up in nearby properties. A 1.5 metre diameter sewer tunnel is half-filled, and heavy rain could so augment the flow to be conveyed as to result in flooding. Clearing blocked sewers in London costs £18m annually.

SOURCE: PRYNN, Jonathan, 2019, Lurking under

London ... a 100-ton ‘concreteberg’. *Evening Standard*, 18 April 2019, page 13; Sarah MARSH, 2019, Concrete blockage 100m long in London sewer. *The Guardian*, 19 April 2019, page 13.

Third London road tunnel under Thames gets the go-ahead

The new Silvertown tunnel under the Thames will effectively eliminate congestion and slash air pollution around London’s worst road bottleneck, transport chiefs have claimed.

On 30 May TfL nominated the RiverLinx consortium to design, build and maintain the £1 billion twin-bore crossing between the Greenwich Peninsula and Royal Docks, with work starting this year. It is set to open in 2025.



Artist’s impression of the Silvertown Tunnel

It will be the first permanent road crossing east of Tower Bridge since the QE2 Bridge at Dartford opened in 1991. A TfL spokesman said it would end the misery of the near-constant traffic standstill at the northern and southern approaches to the Blackwall tunnel, half a mile away, which have some of the highest levels of pollution in London.

Drivers using the new tunnel and the Blackwall tunnel will be charged an additional toll to cover construction and maintenance costs. Around 37 buses an hour will run in each direction linking places such as Stratford and Canary Wharf to Eltham, Grove Park and Charlton for the first time.

SOURCE: *Evening Standard*, 30 May 2019.

GPO tunnel under Gracechurch Street, London

Archaeologists excavating at the site of the Roman forum at Gracechurch Street in central London have examined a tunnel made for the General Post Office in 1977.

SOURCE: MARSDEN, Peter, 2019, Reconstructing the forum and basilica of Roman London. *London Archaeologist* 15(8), 219–221.

Proposed new rail tunnel, Glasgow

Glasgow has long had an urban underground railway consisting of two concentric circular tracks which pass under the river Clyde twice, and go around the city centre. There is now a proposal for a new metro system including a city centre railway tunnel. The suggested new

line linking Paisley Gilmour Street to Glasgow Airport would give a connection between the City's Central and Queen Street stations and a new subsurface station.

SOURCE: ANON, 2019, City calls for Glasgow Metro: Queen Street to Central tunnel proposal. *Modern Railways* 76(849), page 13.

New Lyon – Turin Alpine route rail tunnel, France to Italy

During 2015 the then President of France and the Prime Minister of Italy signed a joint agreement to build a new Mont Cenis or Mont d'Ambri 57.5 kilometre base tunnel. This was to run from Jean de Maurienne in France and Susa in Italy. The new tunnel was to run to the north of the existing Fréjus tunnel on the line via Modane.

The new tunnel was planned to be partly in France (45 km) and partly in Italy (12.5 km). In more recent years doubts have been cast on the viability and future of the project. At present nine kilometres of the main tunnel has been bored, along with 21 km of associated access tunnels.

SOURCE: ANON, 2019, Turin-Lyon Alpine route to be cancelled? *Modern Railways* 76(849), page 80.

Progress with the Brenner base railway tunnel, Austria to Italy

The long-established main railway southward from Innsbruck in Austria over the Alps into Italy runs above ground through the Brenner Pass, with an international frontier station alongside toll booths on the parallel motorway. To allow the railway to gain height at a manageable gradient within the distances both sides of the summit, the builders provided segments of helical tunnels on the approaches.

The new base tunnel will run straight through the mountain for 64 kilometres, making it the longest railway tunnel in the world. Nine kilometres of the central pilot tunnel to accommodate access for services and emergency vehicles has been bored; when completed it will also to be used for drainage. 21 kilometres of access tunnels have also been made. Single-bore running tunnels will be driven either side.

SOURCE: ANON, 2019, Brenner base tunnel progress. *Modern Railways* 76(849), page 80.

Subterranea Britannica

Autumn Meeting 2019

**Saturday 19 October, commencing at 10.00am,
Room 1.09, Palmer Building*, Whiteknights,
Reading University RG6 6UR**

The day will take the usual format, with refreshments on arrival, before the meeting starts.

There are four diverse speakers for us:

Adrian Armishaw will talk on Sutton Coldfield Air-Raid shelters

Ed Waters will tell us about Sandford Hill Lead Mines

Chris Grey is talking on Two Railway Tunnels and their Construction Disasters
(Bramhope, Yorkshire 1849 & Hose, Leicestershire 1876)

Prof Patrick Major talking on his work about Cold War Berlin 'Ghost Stations'

The programme and speakers will be confirmed on the website and as always we are very pleased to welcome short talks or updates from Members – presentation facilities will be available.

Contact Phil Catling on pcatling@subbrit.org.uk

Cost £23 to include refreshments and a buffet lunch, or £25 on the day.

Please book in advance via the website at www.subbrit.org.uk/events
or by post to our registered address

Non-members are very welcome to attend

*Note about the Reading venue:

Palmer Building is on the Whiteknights Campus, with entry from Shinfield Road. There is plenty of free parking. Alternatively, Reading Station is easily accessible from London and points north and west; there is a 10-minute bus ride from the station to the Campus, operating every 15 minutes.



Sub Brit Berlin Study Weekend, May 2019

Vincent Stenhouse and Martin Dixon



Airlift monument

The history of Berlin spans 800 years, originating as part of the Holy Roman Empire, then Brandenburg Prussia, the Kingdom of Prussia, until becoming the capital of the unified German Empire in 1871.

It went on to be the scene of many of the pivotal events of the mid- to late twentieth century; the rise and fall of the Third Reich, the Berlin Airlift, the Wall and finally the capital of a united Germany after reunification. It is this recent history that drew 46 Sub Brit members for a long weekend in May on a packed agenda to study the structures from a time of great enmity with friends old and new.

Tempelhof

Those who could arrive by midday Friday had the opportunity to visit the now disused airport at Tempelhof, to the south of the city. It was once a parade ground for the Prussian Army but early flight demonstrations were made at the site in 1909, including by aviation pioneer Orville Wright.

The site was formally designated as an airport in 1923; Deutsche Lufthansa was founded here three years later. The original terminal was the first in the world with an underground railway station – opened as *Flughaven* but today known as *Paradestrasse* as the later terminal was built further to the north.

Towards the end of WWII the airport was liberated by the Red Army and in May 1945 both Allied and German signatories to the German surrender landed at Tempelhof. Postwar, the airfield was occupied by the US Air Force, whose signage is still prominent on many buildings; they only moved out in 1993.

Most of the group passed through *Platz der Luftbrücke* en route to the airport itself. Here those who took part in the Berlin Airlift after the Soviet blockade of surface routes in June 1948 are commemorated. During the Airlift, almost everything that was required to allow the western sectors to operate was airlifted into the city.

Airlift lasts over a year

The Airlift lasted 15 months (26 June 1948–30 September 1949) and comprised over 200,000 flights, with the record day delivering almost 13,000 tons of supplies – from coal to cola. Almost eighty pilots died during the airlift and the *Luftbrückendenkmal* (Air Bridge Monument) commemorates their sacrifice, taking the form of three huge ribbons which symbolise the three air corridors designated for the transit of Soviet territory.

To supplement the official supplies, many pilots dropped sweets on their approach for the starving children outside the airport and became known as ‘candy’ or ‘raisin’ bombers. The original candy bomber, Gail Seymour



“Hal” Halvorsen, is still alive at 98 and known as Uncle Wiggly Wings!

The huge size of Tempelhof’s terminal building became apparent as we approached closer. It contains over 9,000 rooms and is today largely disused.



Baggage belt beneath the huge cantilevered roof of the departure area. Photo Clive Penfold

We met at the former GA (General Aviation) Terminal which was built in 1950–51 before more extensive postwar repair work. We had two guides, one of whom – Klaus Eiserman – worked at the airport for 37 years until its closure in 2008. We started our tour in the Departure Hall, where the exquisite marble cladding that decorates the internal walls suddenly stops at the point where construction had reached when World War II broke out.

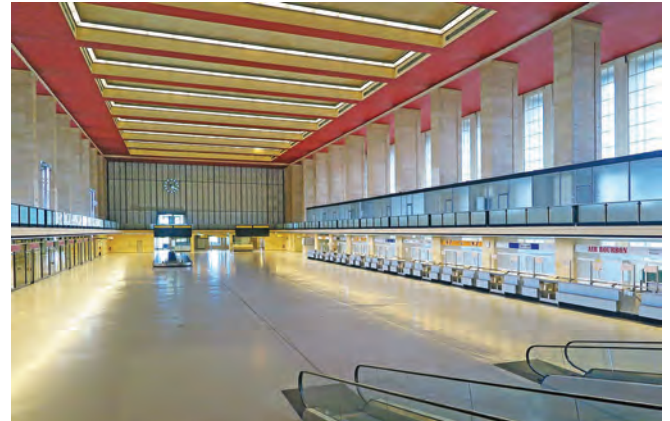
Onto the tarmac

We next ventured onto the apron where a Douglas C54 Skymaster was parked. The plane had taken part in the Airlift and helped give the outlook some scale, for looking back at the terminal building we saw a frontage of 1.2 km. The central 400 metres or so is sheltered by a vast 40-metre-wide cantilevered roof, allowing planes to be boarded in the dry, whatever the weather. Remarkably, this structure pre-dated Heathrow which, when built ten years later, initially relied on marquees and duckboards to host passengers.



Douglas C54 Skymaster on the apron at Tempelhof Airport. Photo Clive Penfold

From above, the whole complex resembles an eagle in flight, with the check-in area being the body and the hangar/boarding area the wings. For parades and air shows the roof could accommodate 100,000 spectators. After closure, the citizens of Berlin took a vote and the airfield itself is now preserved as a green space; we could see thousands of people taking advantage of the area for sport and leisure.



The vast main check-in hall, now eerily deserted. Before WWII damage, the back wall was all glass, allowing a view out onto the apron. Photo Clive Penfold

We passed through the vast check-in hall and then descended to the extensive underground space. Through a blast door we entered a series of underground air-raid shelter rooms, each with an emergency escape ladder at the rear of the space. There was a series of hand-drawn cartoon murals, some somewhat risqué, which were painted, we were told, to keep the children amused during raids.



General view of air-raid shelters, with hatch to emergency exit ladder in the back wall. Photo Clive Penfold



Murals in the air-raid shelters beneath Tempelhof. Fine script in shelters is often an indication of an early date in the war. Translations welcome! Photo Clive Penfold

US Air Force

A separate entrance led to a US Air Force briefing room – complete with raised stage. Next door was a large operations room with all equipment removed but still holding a large wall-mounted plan of the airfield. This suggested it was a battle HQ for the airport itself rather than for planning missions. Labelled hooks at the rear showed where Officers’ personal headsets would have been hung.



Ventilation Plant for the US Air Force bunkers beneath Tempelhof. Photo Clive Penfold



Railway Tunnel beneath Tempelhof. A gantry is just in view top left, from which aircraft parts would have been unloaded in World War II. Photo Clive Penfold

Finally we entered another suite of USAF underground rooms, which looked like the operational headquarters for the base. Extensive ventilation and filtration equipment was still in place and the original ventilation motor was run up for us. A secure room labelled ‘weapon store’ was found to be empty. Retracing our steps we thanked our guides and left with a sense of how the German population could have been convinced about how the National Socialists were indeed building a new World Capital.

Underground

Outside again, we walked to a railway tunnel which would originally have been used for freight and mail carriage but during the war provided a safe unloading point for aircraft parts when the airfield was used for assembling aeroplanes. Re-entering the main building, we descended to a series of burnt-out rooms which we understood had been ‘liberated’ by the Russians using high explosives. Unfortunately, highly inflammable film was stored within and the whole of the contents was lost in a fierce fire. ‘You’re only meant to blow the bloody doors off ...’

On Saturday, we travelled across the city using public transport, including, of course, the U-Bahn. Berlin’s U-Bahn (*Untergrundbahn* meaning underground railway) was first opened in 1902 which places it midway between Paris (1900) and New York (1904). It has since grown to ten lines with 173 stations and over ten million passengers a week are being carried. The first lines ran broadly east–west and connected the suburbs of Charlottenburg, Wilmersdorf and Schöneberg with central Berlin.



To reach less affluent suburbs, north–south lines were needed and work started on these in 1912. Work was suspended during World War I but by 1923 the first stations on the new line opened. World War II caused much damage to the network but expansion continued under the ‘200 kilometre plan’ (although even today only 152km has been achieved).

Trains continued to run in the Soviet sector until the construction of the Berlin Wall. At this time, two lines ran into East Berlin but all stations were closed with the exception of Friedrichstrasse which became a designated border-crossing point. Other East Berlin stations on routes from the west were patrolled by armed East German guards.

Penguins!

On Saturday morning, in true spy-novel style, we gathered under the clock in Alexanderplatz at 0830 precisely for a meeting with strangers who could reveal secret sites to us. Our contacts, Sascha and Katie, from *Berliner Unterwelten* (Berlin Underworlds Association), were our guides for the day.



*The group gather in the underpass below Alexanderplatz.
Photo Clive Penfold*

On entering Alexanderplatz air-raid shelter into what was until the 1990s an underpass, we were briefed to gather like penguins and bunch up, as raised voices only led to reverberation in the enclosed spaces; from then on just the word ‘Penguins’ had us shuffling together obediently.



*The Alexanderplatz underpass descends beneath the road.
Photo Clive Penfold*

Created in 1940 from the foundations of a Peter Behrens-designed skyscraper, the two-level shelter for 3,500 persons is ten metres underground, with walls 1.8m thick and the roof around 2 m. Wartime access was via dedicated stairways from the square above, the doors to which would be shut when bombing became audible. Three sets of ramps designed to maximise foot traffic led to spine corridors and rooms intended to sleep 120 persons in each with many more standing.

Luminous Paint

Later in the war the shelter would cram in up to 50,000 people. Separate toilet spaces were replaced by facilities at the back of each room in order to keep people’s movements away from the corridors. An extensive ventilation system served every room, but the drainage channels in the floor would run with the condensation created by so many people.



The sump at the lowest level of the Alexanderplatz shelter; the various brick types revealing GDR-era repair and modification. Photo Clive Penfold

In May 1945 the bunker was flooded, allegedly by the Gestapo, and after VE Day the shelter was stripped of any materials that could be used for reconstruction. Of particular note was the use of luminous (Copper Zinc Sulphide) paint for wall signage that still retained its properties to this day, giving out an eerie glow after even brief exposure to torchlight.



Corridor in Alexanderplatz bunker. Photo Clive Penfold



The shelter lay disused until the 1960s when new entrances were built from the pedestrian subway and from the road tunnel under Grunerstrasse, the intent being to shelter government officials in times of crisis. The facility was never commissioned, however, though one room did serve as Berlin's store of GDR banners and flags, the regime being rather fond of parades. The translation we were offered of this space was that it was the 'Room for Official Waving Equipment'!

After the collapse of the Berlin Wall, proposals to use the space as an arts centre or night club came to nought, though the bunker scenes from the 2004 film *Downfall* were shot here and the site was used for storage on and off. As of 2019 its destruction is imminent and we have been privileged to be some of the last visitors to explore it.



*The precarious portal to the Tiergarten road tunnel.
Photo Clive Penfold*

Tiergarten

A short hop on the S-Bahn and a walk through the Brandenburg gate took us to the Soviet War Memorial in the Tiergarten, where passers-by were amused to see us don hard hats and head torches whilst loitering and comparing designs of travel wellies, all on a sunny day with not an underground space to be seen.

Disappearing behind the trees, we descended an 8m ladder in what was an air shaft into the incomplete and abandoned 100m section of tunnel below. With our guide whispering to prevent incurring reverberations of up to 17 seconds, we had to be good penguins and listen intently as he described how this was to have been a four-lane road tunnel that would bring the proposed N-S highway



Dividing wall in Tiergarten tunnel. Photo Clive Penfold

to intersect with the already completed E-W road above, the whole system being to enable the adoring millions to come in droves to hear their leader speak from the heart of the Reich's remodelled capital.



Northern section of Tiergarten tunnel, site of the WWII factory. Channels in ceiling were for street lighting and signage. Photo Clive Penfold

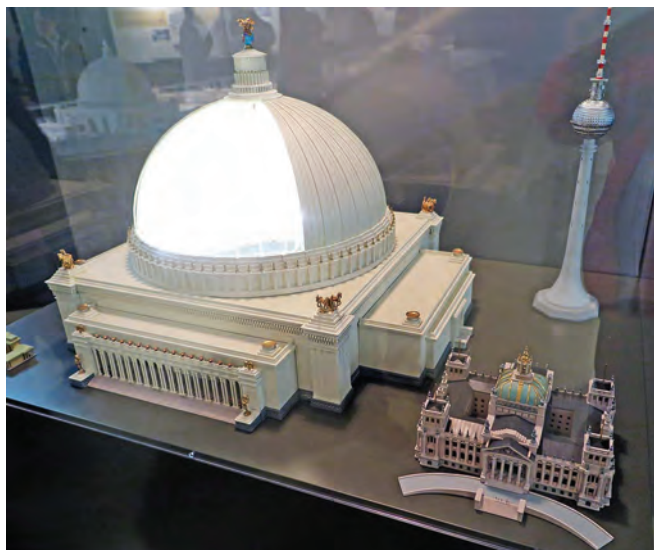


The wartime steps into the Tiergarten tunnel, heavily worn by factory workers and those seeking shelter. Photo Clive Penfold

Started in 1938 and halted in 1941 this cut-and-cover tunnel section, later bisected with a wall housing two doors, served as an underground factory and unofficial air-raid shelter, though in that role it would have offered scant protection with only 50cm of concrete overhead. In the northern corner a brick staircase led up to the now sealed wartime entrance; the extensive wear on every step testament to how busy this site would once have been, despite never fulfilling its original purpose, which was part of perhaps the grandest plan ever formulated for any city in history.

Germania

Two trains took us to Gesundbrunnen and the *Germania* exhibition, tucked away in a space alongside a U-Bahn station once used by the police to monitor the citizens passing by. Revealed within were the grand plans and models for this ‘new World Capital of the Third Reich,’ as dreamt up by the Nazis in the 1930s and put in the hands of their chief architect Albert Speer to make real. The whole of central Berlin was to be razed and rebuilt, and indeed the planners were heard to welcome the first Allied bombing raids for doing some of the demolition for them. The triumphant arch was to be 100m high; symbolically big enough to fit France’s *Arc de Triomphe* beneath it, and the *Volkshalle* (People’s Hall) was to be 300m high, which would have formed the largest enclosed space ever constructed, with a dome sixteen times larger than St Peter’s Basilica in Rome and accommodating 180,000 people. Incredibly, this massive structure was to span a diverted River Spree, further complicating an incredibly complex build, such was the hubris of those who imagined such an edifice.



Scale model of Volkshalle of Germania and two familiar Berlin sites for size comparison. Photo Vin Stenhouse

The incalculable cost of the scheme was to be met through plunder of captured territories, but in the end plans and models were all that was to become of Germania, with the exception of a few ministry buildings and the abortive road and rail tunnels that we had sampled earlier.

The soft ground and high water-table of Berlin, whose name is derived from a word for ‘swamp’, was to make such massive buildings unfeasible, this being proven by testing how far a 12,000 tonne test weight, the *Schwerbelastungskörper*, sank – the answer, at 19cm, being too far. The Führer had proudly boasted about Germania: “Give me ten years and you will not recognise Germany” – he certainly made sure of that.



The entrance to the Gesundbrunnen air-raid shelter. Photo Berliner Unterwelten

Gesundbrunnen

Our next site, Gesundbrunnen air-raid shelter, was built at the start of the war in a 21m deep cut-and-cover void alongside the entrenched U-Bahn. This four-level structure, with just 80cm of concrete overhead, was initially intended for brief occupancy by up to 1,000 train passengers, seated on benches and with generous toilet facilities, these being labelled ‘abort’ as the word toilet was too French for the Reich. Later in the war up to 4,000 crammed in, standing room only, no way to reach the facilities.

Our guides described how the insanitary overcrowding in a building with no ventilation made for unbearable conditions; at times candles would be used to check air quality – if one went out due to lack of oxygen then everyone was evicted regardless of any raids that may be taking place.

With all the precursors of panic in place – crush, heat, humidity, bad air – more use of the luminous paint was



Worn but still effective, the luminous paint in the Gesundbrunnen bunker. Photo Berliner Unterwelten

made throughout including the entire control room and medical bay. Just enough light to see by would be reassuring when the power went off, as it frequently would have.

The shelter lay largely forgotten until 1998 when it was rediscovered by *Berliner Unterwelten*. Today it forms their headquarters and as well as telling the story of its role in World War II it includes other aspects of Berlin's underground, including U-Bahn carriages, pneumatic post, sewers and breweries. The last set the tone for our final stop of the day – *Restauration 1840*, a restaurant under the arches of the S-Bahn, for a true German feast of sausages, sauerkraut and excellent beer.



Good company, good food and good beer. Tony nervously anticipates the bill. Photo Clive Penfold

A Day in the country

Early on Sunday morning we boarded a local coach and set off for a full day exploring the former East Germany. As we drove into the suburbs we passed Humboldthain Park, the site of one of the immense Flak Towers built in World War II.

Postwar, the park was used to dispose of rubble from bomb-damaged buildings and today only the top of the immense structure lies exposed, creating a viewing platform for the surrounding district. Soon afterwards, we passed Bornholmer Bridge, which was the first border crossing between East and West Berlin to be opened at 2120 on 9 November 1989.

Our first site of the day was between Lobetal and Lanke, about 30 kilometres north of Berlin. It was built in 1939 as a Marine Communications School, complete with underground bunker, and like many such structures it was built in a heavily wooded area to make it difficult to spot from aerial reconnaissance photographs.

As Allied air raids began to threaten Berlin, it was decided to relocate the command centre of the High Command of the German Navy (*Oberkommando der Marine* or OKM) from near the Tiergarten to a site that offered greater protection. In January 1943 the underground bunker was thus repurposed and christened *Koralle* or Coral. This seems to break a cardinal rule of codenames – never

choose anything which might hint at the purpose of the project or structure (coral being marine creatures).

Bletchley Park

Amongst other things, the bunker acted as the communication hub for signals to U-boats, signals which we now know were being intercepted and decoded at Bletchley Park. As well as the command bunker, there are other protected structures on site including an anti-aircraft position and a large air-raid shelter.

The latter is a model T750 (T for *Truppenmannschafts Bunker* or literally Troops Crew bunker) – a standard naval design to accommodate (nominally) 750 troops. Around 32 T750s were built, usually around dockyards and barracks, and troops were protected by 3.75-metre-thick concrete roofs.



The double steel gates to the Koralle bunker site. Photo Clive Penfold

Entering the 1.5 x 1km area that enclosed these sites through double metal gates, our attention was drawn to the GDR workers' battalion huts and the WWII fire ponds, forest fires being a major concern for sites hidden by trees. All the ponds were made different shapes to give a more natural look to the area and fool reconnaissance efforts, though the Allies saw through that and sent a raid that missed this target but serendipitously hit Goebbels' villa 5km away.



Block walls rise above the remnants of the Koralle briefing bunker and AA site. Photo Clive Penfold

Walking on past prefabricated huts and Trabant garages that all had false walls concealing ammunition stores, we arrived at the demolished WWII briefing bunker, the two floors above ground and one below barely discernible in the tangle of rebar and shattered concrete. Where once were mounted some small-calibre Flak guns, today incongruous block walls rise vertically from the wreckage, a GDR-era addition when the site was used for street-fighting training.

A few hundred metres away the T750 bunker, equally wrecked, revealed fishbone rebar amid the rubble. The method of demolition employed by the Soviets was to pile all the munitions they could find in the bunker and detonate it, blasting the side walls out and letting gravity do the rest. The emphatic result certainly removed the option of reuse, but flung live munitions across the woodland; we were told to stay on the path and, for once, we did.



Inside the Koralle bunker, the group gather for a briefing, the general dilapidation evident. Photo Clive Penfold

Down the hatch

The Soviets also blasted the communications centre that sat atop, and housed the entrance to, the 1560 sq m *Koralle* bunker, though not before using it themselves for a number of years for comms and munitions storage. As befitting the HQ of the submarine forces, access is now through a hatch and down a ladder.



Koralle bunker; the missing floor shows the limited headroom below. Photo Vin Stenhouse

Dropping into what was the air-raid shelter room and through a heavy blast door, we found a long corridor with a number of Soviet-era dormitories off leading to the larger rooms that made up the WWII nerve centre of this strategic site, their floors long since collapsed.



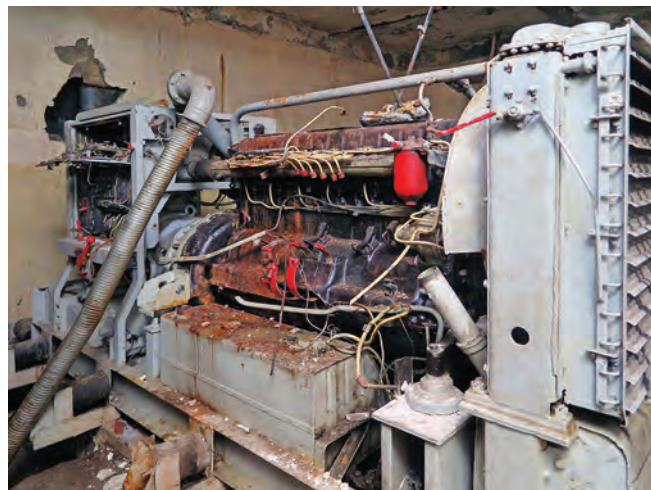
Remains of the Soviet-era kitchen in the Koralle bunker. Photo Clive Penfold

A spiral staircase led up to reveal the steel door of the original entrance, now sealed and buried, and another set of stairs led to the lower floor, where headroom was noticeably lower and all the bunker services were housed: the plant and filter rooms, 15m borehole, heating and an incinerator.



Soviet air filters bridge the colour coded external and internal air systems. Photo Clive Penfold

Two large diesel generators remain in place, too bulky and heavy to recover, but overall the bunker is an empty shell, stripped by the Soviets. Back outside, poor navigation led to our taking the scenic route to the coach.



One of two diesel generators that provided independent power for the Koralle bunker. Photo Clive Penfold

Lunch was taken on a patch of grass in a local village, much to the chagrin of a local dog walker whose charge had to cross its legs a while longer until all the interlopers were driven away.

Harnekop – copper-bottomed protection

The GDR-era Harnekop bunker, the main command bunker for the East German Ministry of Defence, was surrounded by a veil of secrecy so tight that the troops stationed here did not know its purpose. The 5,000 workers who built it between 1971 and 1976, though housed locally, were driven round for 1.5 hours in a bus with blacked-out windows before arriving, so they never knew the location.



The Harnekop 'weather station' was encircled by a double electric fence with a lethal current - stealing their thermometer would have been difficult. Photo Clive Penfold

Even the chief command of the GDR did not know the location of this vast 'weather station', protected by a high-voltage electric fence, whose two-storey office block was only there to disguise the entrance to the 7,500 sq m three-level bunker below. The subterfuge worked well and NATO intelligence only became aware of this site in 1990 when the German army took it over.

Known officially as SBW 16/102 (SBW being *Schutzbauwerk* or 'protective structure'), it was also known as HNZ-8 (*Hilfsmittelnachrichtenzentrum* or 'auxiliary message centre number 8'). Measuring 63m x 40m x 23m deep and with 150 rooms, the bunker has 3m thick walls and roof consisting of a 1.5m slab, then a 4.6m air gap, then more concrete above, this to detonate penetrating weapons before they breached the bunker itself.

Beneath the 3m-thick floor the bunker sits on a 6cm layer of copper for electromagnetic protection. So advanced was this design, offering 'Class A' level of protection, that copies were made in a number of places, including Baghdad. The site was crewed by seventy soldiers day and night and maintained at maximum readiness at all times.

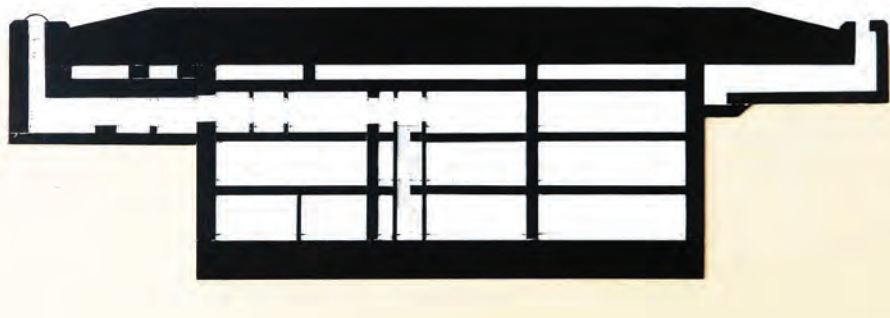


The Harnekop main building, just your average office block, though with a bigger than average basement.

Photo Clive Penfold



The blast door between the Harnekop bunker and the access tunnel. Photo Clive Penfold



Harnekop bunker layout.

Our guide, a proud ex-GDR Special Forces operative, replete with original uniform and rather large knife, took us through the site's main gate and down the precast concrete road to the 'offices'. The original entrance building, clearly too small to house the dozens of people who would come and go every eight hours, was supplanted with a much larger one that could feasibly host such numbers.

Within this, a tunnel accessed from a short flight of stairs led through a number of blast doors, though not the one designed to withstand 1500 degrees of heat – the National Security Agency (NSA) took that away for analysis and didn't return it.



The Zeiss computer system at Harnepok, state of the art at the time. Photo Clive Penfold

The heart of the bunker is the dispatcher room, with banks of status lights for all functions, and the controls for an access and air management system that could switch to fully automatic lockdown mode in 0.2 seconds, the bunker being able to then operate fully locked down for 28 hours. The large Zeiss mainframe system in the computer room was used 24/7 to justify the huge cost, ‘hiding military data within that of private citizens’, as our guide explained.

Floor sprung door technik

The bunker was designed to survive a Hiroshima-size bomb being detonated as close as the site perimeter, deflecting up to 40cm on its bed of 2,100 helical coil springs, these isolating the vital components, and making our passage through the rooms a little wobbly, for some of us more than others.



Main operations room Harnepok, where world events could be both monitored and directed. Photo Clive Penfold



Harnepok bunker dispatch room, the red lever being to switch between bunker readiness modes. Photo Clive Penfold



The lower bunker room floors were held down against the force of the springs with latches in each corner; the shock of any nearby blast would break these, freeing the floor, allowing it to oscillate independently of the main structure. This would also effectively bar the inward opening doors and trap the occupants, the solution to which was a manual floor recompression device that would push it back down again.

Many of the rooms contained bread bin-sized devices that were simultaneously carbon dioxide scrubbers and oxygen generators, literally a last gasp option should the air quality become dangerous.



The Minister's desk, Harnekop – one of these phones was a hotline to Moscow. Photo Clive Penfold

The middle floor was living space, with barrack rooms stacked with 172 bunks for up to 450 soldiers in wartime conditions; well-equipped kitchen facilities held 3,500 meals in readiness at all times should this transpire, to be consumed in the canteen under the painting of a bucolic country scene.



Canteen facilities at Harnekop. Photo Clive Penfold

An extensive comms facility of phones, teleprinters and pneumatic tubes fed information to the GDR officials housed in rather more luxury above, a private dining room and bedroom for the minister and a suite of briefing and planning rooms, where the bank of TVs could also swing freely on sprung platforms.



The Harnekop kitchen. Photo Clive Penfold



Teleprinters at Harnekop, part of the extensive communications function in this hidden ministry building. Photo Clive Penfold



Pneumatic tubes enabled secure transfer of papers between rooms of Harnekop. Photo Clive Penfold

The bunker was, unlike many, entirely watertight until the Western intelligence agencies arrived. Having not had any leaks about this site for two decades, they drilled holes through the floor and a wall 'to assess construction methods' and in doing so made leaks of their own – then they made off with the best door; symbolic acts maybe.

Garzau bunker

In a similar mould to Harnekop, the Garzau bunker is accessed through a nondescript office building. Designated *Objekt 05/206* and built in 1972–75 for the NVA (East German army), this 4000 sq m facility served as a data centre, primarily for logistics, the whole structure being a Faraday cage to protect the computer systems and their data.



*The Garzau bunker controller monitored and directed all aspects of the services from this console.
Photo Clive Penfold*

Like Harnekop, key rooms are spring-mounted and the roof is two layers with a gap between, though this bunker had a lower ‘class B’ level of protection due to a lesser ability to operate in full lockdown: 24 hours, then limited protection for two more weeks. Abandoned in 1993, the site was stripped of its computer equipment and is now maintained as a museum.



The long uphill walk into the Garzau bunker from the office block entrance. Photo Clive Penfold

Similar to a UK Rotor bunker, Garzau is accessed by a long tunnel, though one that goes unusually uphill for 200m to the entrance at a depth of 17m below the rising ground. A series of four blast doors gave access to this two-level site, roughly 50 metres square, and at the heart of each floor are the computer rooms that offer full dual-redundant system protection, similar to modern practices.



The outermost 1.6 tonne blast door at Garzau, one of four in succession. Photo Clive Penfold



Some homely touches counter the austerity of the Garzau canteen. Photo Clive Penfold

The computers were largely IBM-compatible directly copied from Western technology. When they were operational no additional heating was required in this bunker, only cooling, as temperatures would rise to 30 degrees in places.



Just a few contemporary computer components remain at Garzau. Photo Clive Penfold

The compressed air supply, capable of releasing 10,000 cubic metres of air during a 24-hour lockdown, was stored in six large 160-bar cylinders, while four diesel

generators provided emergency power. Three of these engines, resting on a bed of springs with flexible fuel lines and concertina exhaust pipes designed to withstand intense shaking, are painted a military green, with one a canary yellow. This anomaly was due to the authorities, running short of such engines, requisitioning one from a funfair, a tale that does little to overcome the Cold War perception that the GDR regime were a joyless bunch.



Stored air tanks and both parts of the portable combined Oxygen generator/CO2 scrubber. Photo Clive Penfold



Standby generators . Photo Clive Penfold

Back in Berlin, another fine meal of classic German fare was had at the *Zollpackhof* restaurant, with full steins, schnitzel and strudel and a schnapps that could reanimate the dead.

The Forbidden City

Wünsdorf was, from circa 1870, a Prussian Army shooting range but by World War I the area had gained railway access, a host of barracks and at 60,000 acres had become Europe's largest military complex.

By the mid-1930s, the base had become the headquarters of the *Wehrmacht* – the Nazi armed forces, then postwar the Soviets took over and Wünsdorf became the headquarters of the Group of Soviet Forces in Germany (GSFG). Any remaining local residents were evicted and Wünsdorf became an isolated (and tax-free) Soviet city of up to 75,000 residents within Germany.

Barracks, training facilities, shops, entertainment and sporting facilities were all created and most Soviets never stepped outside the complex apart from on exercise. Taking full advantage of the Nazi-era development of the site, the Soviets added to and enhanced it for their purposes. Walled-off and with access tightly controlled, the place became known as the 'forbidden city'.



Group photo in front of a statue of Lenin at the Army Sports School Wünsdorf. Photo Clive Penfold

Spitzbunkers

Our coach first took us on a tour of the whole area, past GDR housing and the remains of some of the nineteen iconic *spitzbunkers*, designed to deflect bombs away from the 315 people that sheltered within each one. Some had been later dynamited by the Soviets creating sculptural remains of the tower peaks lying at seemingly impossible angles.

Of note were the fortified bakery that churned out twenty tonnes of bread daily and the small provincial station that had, from 1970 onwards, a daily direct train to Moscow, such was the importance of this area known to many as 'Little Moscow'.



One of the few intact Wünsdorf spitzbunkers. Photo Clive Penfold

Strenuous efforts by our organisers had secured us access to the site of the army sports school Wünsdorf, where athletes had trained for the 1936 Berlin Olympics and which was later used by the Soviets to house their officers, with the obligatory statue of Lenin out front glowering over a parade ground. Our guides gave us access to the five-storey school building, dating from Prussian times, along with the swimming pool, fencing school and theatre, all remarkably undamaged after 25 years of neglect.

The Russians abandoned the forbidden city rapidly in 1994, leaving behind vast quantities of ammunition and other waste; there are tales of them abandoning pets and, as if to add veracity to that, at the back of the theatre lies the desiccated remains of a dog.



*The main gates of the extensive Wünsdorf site.
Photo Clive Penfold*

Bunker houses

Returning to the book town of Wünsdorf-Waldstadt, the tour continued on foot to the Maybach 1 site of twelve bunker houses, made operational just one week before the outbreak of war in 1939 and named after the tank engine (and luxury car) manufacturer.



*Our guide briefs the group at the Wünsdorf site. All items in red on that map are underground - SubBrit heaven!
Photo Clive Penfold*

Built to simulate a normal house, each bunker was on four floors, the two below ground leading to a 600-metre ring tunnel that connected them and also gave access to

the adjacent Zeppelin bunker. Made entirely of concrete, including the sharply sloped roof, and with steel blast shutters protecting openings, the impression of normality was maintained by painting on windows and adding flower-laden window boxes in summer, though later netting was used to hide the site.



Remains of a bunker house – note the hinges for armoured shutters and fortified chimney. Photo Clive Penfold

General unrest

Each block had a specific purpose: one was used for directing the armies in the East, one directed spies, one for the armies of the other Axis powers and so on. Many of the key military figures of the Reich were housed here, though the Führer never visited, expecting the military commanders to go to him on demand, wherever he may be at the time.



*One of the more intact Maybach bunker houses.
Photo Clive Penfold*

The literal and metaphorical distance helped fuel resentment and many of the plots to overthrow the leader began here, including that of Claus von Stauffenberg (1907–44); AH went on to refer to the Maybach 1&2 sites as the ‘swindle bunkers’.

Bombed by the USAAF in 1945, the bunkers were later demolished as part of the Potsdam Agreement prior to the Russians reusing the site; the surface structures were utterly destroyed though the ring tunnel beneath is largely intact, though out of bounds for us as we were too large a group to safely explore.



Prefabricated protection

A short walk on from the Maybach 1 site, a door in the hillside led to a tunnel under the path to a mound in the trees. This one-level single-room training bunker, built in 1979, was constructed from precast circular sections roughly 6m in diameter and dubbed the 'Ikea-bunker'.



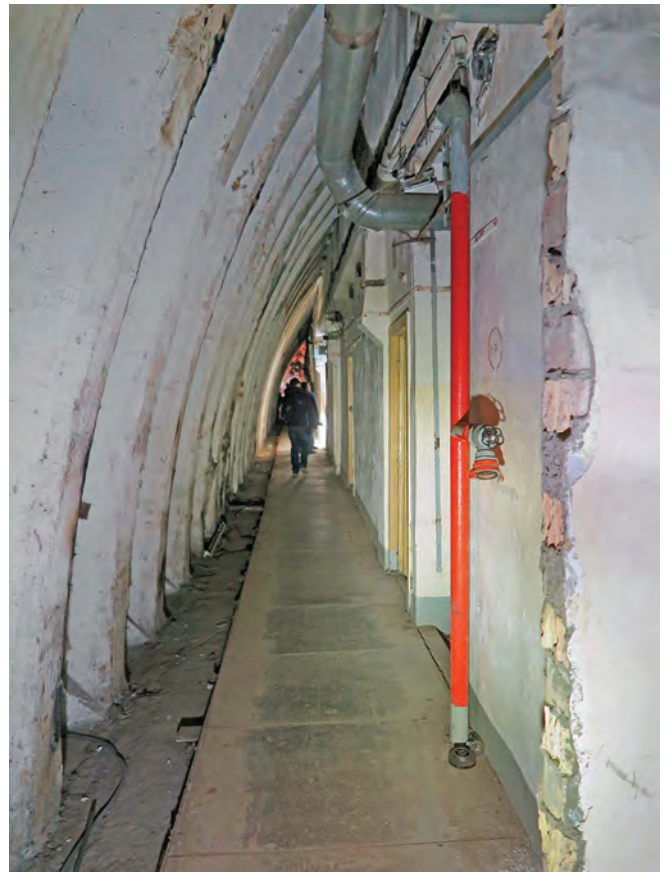
Interior of the soviet communications training bunker at Wünsdorf. Photo Clive Penfold

Further on, we came to bunker UK20 of the Soviet 16th air army, a T-shaped structure also of prefabricated design, its three steel and concrete tubes of around 15m diameter embedded in the hillside using cut-and-cover and divided to give accommodation on two floors.



A rudimentary door now provides entry to the air defence HQ bunker Wünsdorf; in operational times this portal lay within a surface building. Photo Clive Penfold

Its dual-height operations room would once have hosted massive state of the art screens that showed air traffic status across the Baltic and Scandinavia, the data gathered by a system of radars on the north coast. Outside, concrete pillars remain from the structures that hid the entrance, flanked by garages that made the area look like an ordinary vehicle depot.



A corridor in the gap between the rectangular rooms and the circular structure of the air defence bunker.

Photo Clive Penfold



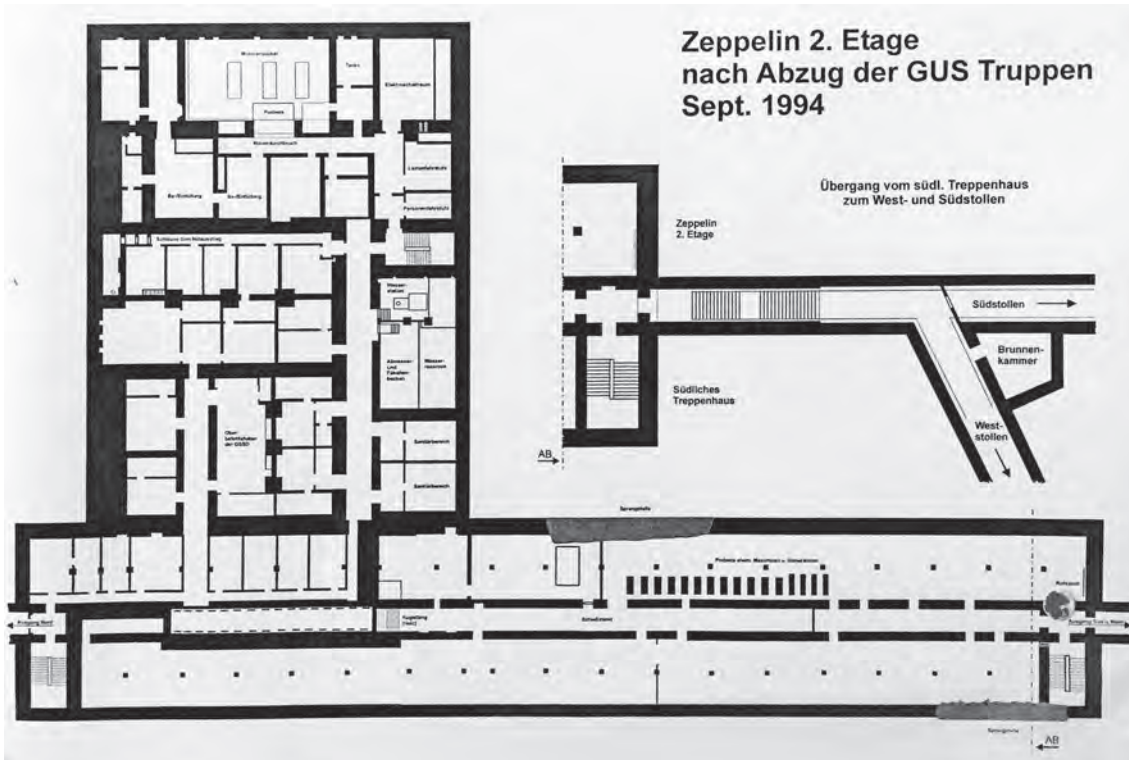
The main operations room of the air defence bunker.

Photo Clive Penfold

Zeppelin/Ranet

We finally arrived at the bunker code-named Zeppelin. This was the biggest communications bunker in the world for good reason, being for the supreme command of the Wehrmacht, the very nerve centre of a country at war on many fronts. Started in 1937, and using only German workers, no slaves, this structure was also one the most fortified of the period.

Above the 3m thick bunker ceiling layers of sand and a special stone packing called *Zerschellschicht*, designed to dissipate blast, made up the 5.5m thick overburden. Consisting of two adjacent and connected rectangular



Layout of top floor of Zeppelin, with detail of the access tunnels

structures, one 117m x 22m with an ‘annex’ of 57.5m x 40m, this three-level site has a floor area of 14,700 square metres.



*Hardened airshaft and emergency exit of Zeppelin/Ranet.
Photo Vin Stenhouse*

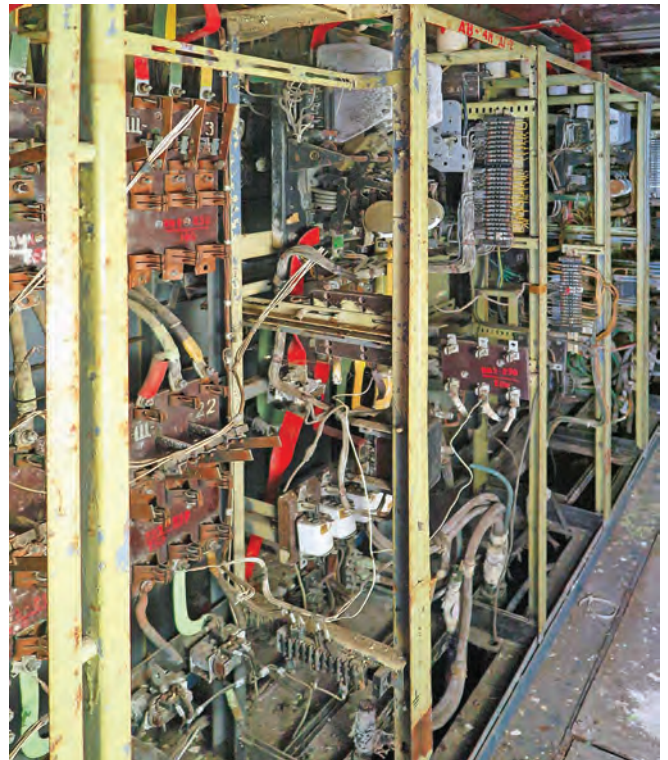


*Zeppelin/Ranet - comms cables and switching gear.
Photo Vin Stenhouse*

The bottom floor at 18m underground housed the services that, if required, would allow the bunker to operate autonomously for long periods. The floors above, at 14 and 16m, were for the telecoms kit and accommodation, though inadequate cooling and all the communications systems operating 24/7 made the bunker an unpleasant place to work, regularly reaching over 100 degrees F.

Protecting active radio becomes radioactive protection

Three tunnels ran from the surface and from the Maybach bunkers, giving access for the 150 workers per shift that started working here in August 1939; the site was abandoned without a fight and with all its systems still running on 20 April 1945. The Soviets stripped out the communications equipment for transport back to Russia, and in 1946 parts of the structure were blown up to satisfy the Potsdam requirements.



*Communications equipment racks in Zeppelin/Ranet.
Photo Clive Penfold*

Entrances were then blocked and the bunker became flooded, but in 1960 the Soviets decided to reuse the bunker in the role of communications centre for the GSFG, codename ‘Ranet’. Such was the scale of the bunker they were able to devote space to a pistol-firing range and a huge sauna, but still many rooms lay empty.

Serious protection



The outer 2.5 tonne blast door added by the Soviets, with curved embrasure. Photo Clive Penfold



The Soviet-era facilities control room on the bottom floor of Zeppelin/Ranet. Photo Clive Penfold

Our entrance was through no less than seven blast doors of up to 2.5 tonnes each, into the extensive decontamination area added during the reactivation along with the NBC system designed to give 30 days’ protection. A spiral staircase took us down through the levels and into mostly empty rooms, some with remnants of the comms hardware. We were allowed into the lowest level which originally held plant and ventilation equipment, sadly mostly now lost.

Our guide, not used to people being so interested in the place, fretted volubly about the time we took taking photos, so we upped the pace to take in the entrances to the tunnels, the rooms full of abandoned equipment and the hole in the roof made during the demolition attempt, one conveniently large enough to lift comms equipment through. Our exit was via the 260m West tunnel, emerging out of an ordinary looking barracks building.



The damage resulting from the partial demolition of Zeppelin. The loss of useable space made little difference to the reusability of this massive bunker. Photo Clive Penfold

Grateful thanks

The tour and the weekend over, we went our separate ways having learned much over this impeccably planned and executed long weekend. Many thanks must go to the organisers of this fascinating study tour, Tony Radstone and my co-author Martin Dixon, in securing privileged access and connecting with *Berliner Unterwelten*, who also deserve our thanks for adding such insight around the sites in their care.

The Otira tunnel, Arthur’s Pass, South Island, New Zealand

What was once described as the longest railway tunnel in the British Empire is still in use at Arthur’s Pass on the single track narrow-gauge (3 ft. 6 ins.) line from Christchurch on the east coast of South Island to Greymouth on the west coast. The 100 mile line traverses the South Alps, reaching an altitude of 740 metres (2,440 feet), and includes the eight miles (five kilometres) Otira tunnel. The tunnel was started in the 1880s, but not opened to traffic until 1922.

The line’s primary purpose is for the daily coal trains from the west coast mines, and is used also for the tourist Tranz-Alpine Express trains. Doubled General Electric locomotives haul the 2,000 tonne eastbound coal trains up to Arthur’s Pass, but the severe 1 in 33 gradient through the tunnel requires four additional locomotives at the line summit. The long tunnel has artificial ventilation. An automated door closes one end and fans draw air through from the far end.



The Otira tunnel in 1910 during construction

SOURCE: WALLIS, Geof, 2019, A remarkable railway in New Zealand. *Industrial Archaeology News* 188, page 21.



Courtaulds Factory Air-Raid Shelters, Essex

Helen Wolf



Entrance to one of the shelters. Photo Emily Hunn

Halstead is a town in north Essex close to Braintree. Samuel Courtauld established a textile mill here in 1818 and his company's factories later became a major local employer. In 2012, Chris Rayner wrote his Subterranea Britannica report on Halstead's industrial air-raid shelters.

Shelters' future is threatened

Within months, an application to build a Tesco supermarket on the site was submitted. The evening the application was refused, Halstead 21st-Century Group (H21C) was formed because we recognised that the threat to the shelters would return.

A military archaeologist's report in 2004 had recommended trying to protect the shelters through the listing process. This advice was followed in 2006. English Heritage replied that "tens of thousands of air raid shelters were constructed during the course of WWII" and despite acknowledging that many had been dismantled, they added that "a considerable number survive."

The Tesco application provided new evidence that the semi-sunken shelters were built by Costain, so H21C requested that they be reassessed for listing in 2013. English Heritage acknowledged the new evidence but added that it was not significant enough "to outweigh the loss of the factory for which the shelters were built." The main Courtaulds factory building was demolished in 1986, however several other parts of the complex survive. H21C was then advised that our best chance of saving the shelters was to save their setting. This idea chimed with our own and formed the basis for our own vision. The shelters are on an unmanaged four-acre green space comprising woodland, springs and the remnants of a Victorian landscaped garden.

However, the land was also a commercial opportunity for the half-dozen or so owners and one of them, Braintree District Council, had designated the land as a Comprehensive Development Area in the emerging Local Plan.

Reports of possible purchasers and failed contracts circulated. Meanwhile, the shelters were approved for the Local Heritage List, and we revised and improved our vision for the whole site to be retained as a town centre heritage park. Then, in February 2018, a local developer became the new owner – subject to planning consent.

Sub Brit helps

Thanks to a grant from Subterranea Britannica, our alternative vision document was launched a few weeks

later. In November 2018, an outline application to build on the air-raid shelter site was submitted which proposed a development of 74 dwellings, 114 parking spaces, and two community/retail units. Indicative plans showed the loss of 12 of the 15 semi-submerged Costain shelters and considerable amounts of woodland.



Looking towards the escape ladder and chemical toilets in one of the shelters. Photo Chris Rayner

Unsurprisingly, consultees complained about the lack of information, and the LPA pressed the developer to provide more reports. He chose not to, and in June, we learned that he had lodged an appeal on the grounds of non-determination.

A Planning Committee meeting was held on 16 July and Councillors unanimously agreed that this application was poor and would have been refused by them if the decision were theirs to make. The report has been added to the weighty evidence the Planning Inspectorate is considering.

We need to save these shelters

Whatever the Planning Inspector's decision, we're convinced that our group of air-raid shelters IS rare and hope to commission a piece of research to prove it.

Please get in touch if this is a project you can help us with.



Defence in Depth

The Underground Fortresses of the Swiss National Redoubt

Tim Wellburn



Fort Sasso da Pigna: The barely-visible manifestation of power. One of the four 15cm guns, its casemate largely concealed within the natural structure of the rock face. Photo Clive Penfold

In August last year, a joint US Coast Defence Study Group and UK Fortress Study Group visit to Switzerland took members to some 25 different sites spanning a century of defensive evolution. The tour is described in the FSG magazine Casemate. This article focuses on some of the larger underground forts of the three great Alpine fortresses of the Swiss National Redoubt [1].

The Swiss National Redoubt

The concept of a Swiss National Redoubt had first been proposed in the 1820s after independence had been secured following the brief period of French suzerainty [2]. It was refined in 1882 by the second Commission for Fortifications which defined two defensive zones: an outer one defending, chiefly, the Swiss

Switzerland, the Swiss National Redoubt (outlined in orange)

and the three major fortress complexes controlling the key Alpine passes: Saint-Maurice; Gotthard; and Sargans.

Note that the major cities all lie outside the Redoubt



plateau region; and an Alpine zone which would act as the National Redoubt.

The strategic logic of the Redoubt was to deter aggression by denying an enemy vital trans-Alpine routes. The initial intention had been to conduct a vigorous defence of the lowland zone, which contained the bulk of Switzerland's population and economic activity, but by 1940 military pragmatism had prevailed. General Guisan's final plan, in the event of invasion, was for an organised retreat to the Redoubt.

Fortifying the National Redoubt

The first phase of fortifying the National Redoubt was initiated by General Dufour [3] in 1830. This focused on Saint-Maurice, a historically strategic town commanding the valley of the Rhone, a key potential invasion route from France. However, by the 1870s, Dufour's infantry towers and open batteries had been rendered obsolete by advances in artillery. Transport improvements also posed new military threats: in particular the opening of the Gotthard rail tunnel, in 1882, had created a major route through the centre of Switzerland linking Italy with Germany.

Following the Commission for Fortifications of the same year, funding was provided for major new works including a complex of fortresses defending Gotthard, and for the upgrading of Fortress St-Maurice. This phase of fortification was largely complete by the early 1890s. The main exception was Fort du Scex, a wholly underground fort constructed in 1911 to further strengthen Fortress St-Maurice.



An armoured observation position of Fort Stöckli, one of the alpine forts built in the 1890s to defend the National Redoubt

Improvements to these fortifications continued to be made in the period up to World War I. In the latter, despite internal political tensions, Swiss neutrality was not seriously at risk once the initial mobile campaigning – with the threat of outflanking incursions into Swiss territory – had stagnated into the static trench warfare of the Western Front.

By the mid-1930s, despite the economic impact of the global postwar depression, a political consensus had

emerged that Switzerland needed to invest in enhancing its defences. In 1937, under conditions of great secrecy, work began on planning new fortifications on the “Border Line”, the “Army Line” (which provided an adjacent defensive position against Germany), and in defence of the National Redoubt.

On 10 June 1940 Italy declared war on France and Great Britain; twelve days later France surrendered to Germany. These two events meant that Switzerland had suddenly become encircled by belligerent Axis Powers [4], with enormous implications for national defence.

The Swiss response was to retrench to the ‘inner’ defensive line of the National Redoubt and to accelerate the programme of building the modern underground forts needed to defend it. This latter task, which involved the construction of many more forts and works than are within the scope of this article, was not fully completed until after the end of World War II.

These fortifications were maintained, upgraded and added to throughout the Cold War. Indeed, Switzerland was one of the last proponents of fixed fortification, with new construction continuing to the end of the twentieth century.

Fortress Gotthard

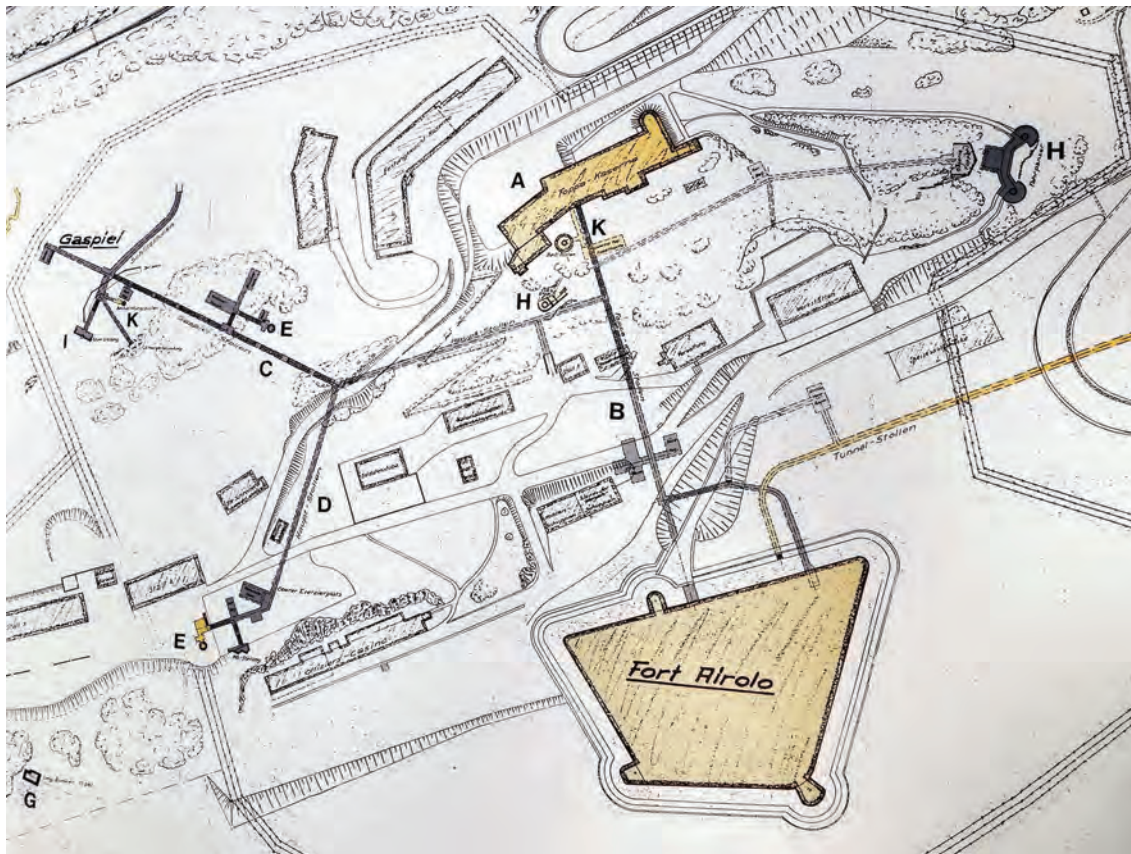
Fort Airolo

Fort Airolo was the original centrepiece of the Gotthard fortress. Built between 1887–90, it was a sunken, squat granite structure armed with offensive and defensive turrets and casemate guns. The main armament was two Krupp 12cm Mle 1882 guns mounted in a Gruson armoured turret. (Only the latter remains; sadly, the army scrapped the guns in the 1950s.) Other forts built as part of Fortress Gotthard in the 1890s included Forts Hospiz and Stöckli (the latter, at 2,460m, the highest fort in Europe).



Fort Airolo: A classic late-19th century granite fort, built just as such structures were becoming vulnerable to rifled artillery firing explosive shells

Airolo's design and construction were already heading for obsolescence by the time it was completed in 1914. Brialmont's Belgian forts were to demonstrate the



Fort Airolo: The network of tunnels linking the fort to the subsequent detached positions. The contemporary tunnel heading east, coloured brown on the plan, runs to the portal of the Gotthard railway tunnel

vulnerability of such compact defensive structures to assault by heavy siege guns [5]. In the light of this, it is ironic that Airolo is one of the few forts still used by the army – albeit as a training base.

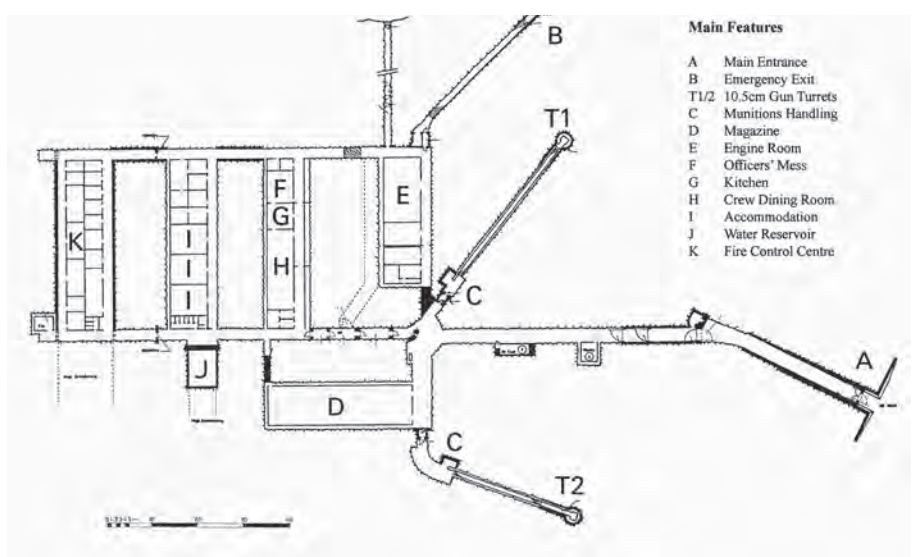
Notably, the fort was linked by a kilometre-long underground passage to a bunker within and defending the portal of the Gotthard railway tunnel. At the turn of the century, the fort was reinforced by a number of remote gun positions constructed above the fort on the slopes of Foppa Hill. These were also connected to it by tunnels. None of these is now publicly accessible.

Modernisation

In 1929 Mussolini had focused Swiss minds by building a road to San Giacomo, within artillery range of the St Gotthard Pass and railway tunnel. Bizarrely, he had a railway dining car and sleeping car installed on concrete pedestals at the top of the pass. Ostensibly serving as a hotel, this was seen as a clear assertion of Italian logistical capability – and territorial ambitions. On Italy's entry into the war, the Swiss immediately commissioned the design and construction of three modern underground artillery forts and various other works [6] to update Fortress Gotthard. Located in the St Gotthard Pass, just north of Fort Airolo, were Forts San Carlo and Sasso da Pigna (the latter effectively

replacing the obsolete Fort Hospiz) and, high above Andermatt, Fort Gütsch (replacing Fort Stöckli).

Fort San Carlo



Fort San Carlo: Plan of the fort, which is built on one level apart from the access slope shafts to the turrets

Fort San Carlo, the first to be commissioned, was effectively the prototype for a new generation of forts incorporating 10.5cm gun turrets. It was built into rising ground on a compact plan. Entry is by a level vehicular tunnel which, after one defended turn, runs straight back into the hillside to a nodal point which gives access to the magazine and guns, and to the accommodation and utilities, constructed in chambers excavated off a pedestrian continuation of the main tunnel.





Fort San Carlo: The base of the slope shaft and ‘paternoster’ ammunition hoist to Turret 1. Note the lack of separation of shell and cartridge. Note also the carbon monoxide warning sign: gun crews were supplied with piped air

The two turrets, on the hillside above, are reached by separate long, straight slope shafts leading off from small munitions handling areas. These shafts each contain a challenging flight of stairs and an electrically-powered chain-driven ammunition hoist (which Swiss sources tend to describe as a paternoster). This appears to have conveyed shell and cartridge side by side in the same cradle. In this fort, both sets of stairs are permanently fitted with rails for gun haulage; in other forts these seem to have been installed temporarily, as required.

A blast door at the top of the shaft gives access to the turret. This has two levels, the lower floor providing a (manual) ammunition handling space and the upper one containing the single 10.5cm L52 39 gun. On the surface, the turrets are encased in irregular light iron



Fort San Carlo: Turret 2, now revealing the construction of its camouflage superstructure

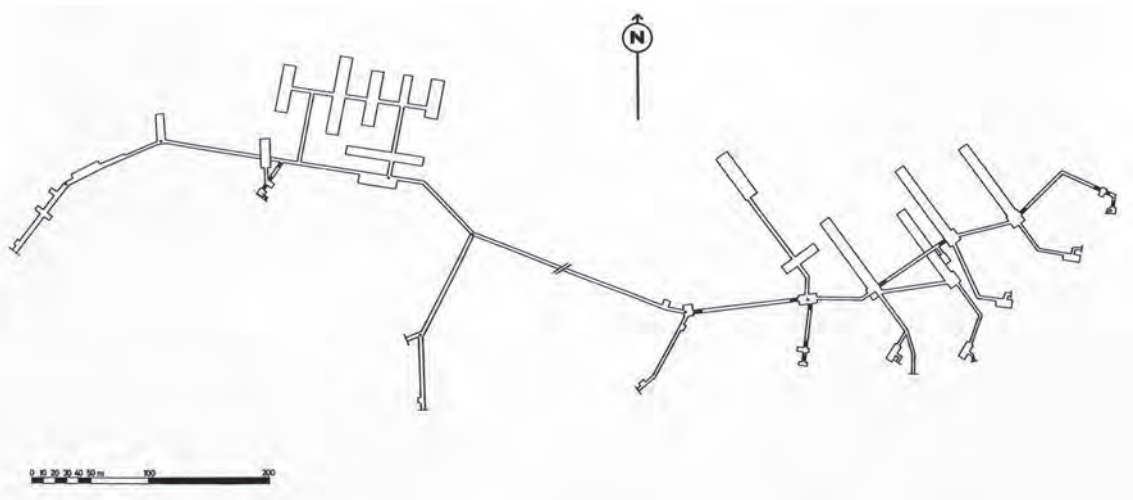
and mesh frameworks with painted cement covering, disguising them as rocks.

There are several casemates built into the hillside above and around the fort, but these do not seem to be physically connected to it: the tunnel shown on the plan, heading off diagonally from the northwest corner of the complex, is a secondary or emergency exit. The function of the tunnel immediately adjacent to it is unclear, but may have provided ventilation for the engine room.

Fort Sasso da Pigna

Fort Sasso da Pigna, the counterpart to Fort San Carlo, was excavated within the mountainside on the eastern flank of the St Gotthard Pass. Here, the requirement was to mount casemate guns controlling the valleys to the south and east. However, the entrance to the fort – a lorry-size tunnel – was constructed a kilometre or more to the west of the gun positions, resulting in an extraordinarily elongated plan. The fort has, in total, some 2.4km of tunnels.

The main accommodation and utilities (which were not completed until 1945) were in a complex of chambers



Fort Sasso da Pigna: The main entrance is at the extreme west of the plan; the gun casemates and their magazines lie at the fort’s eastern extremity, respectively on the south and north sides of the main access tunnel (a section of which is omitted from the plan). Source: ADAB 1998, reproduced on the fort’s signage

excavated to the north of the access tunnel, about 400m in from the entrance. From west to east these were: fort command; accommodation; dining room; food store; and hospital. The chamber lying parallel to the access tunnel contained the air filters and engine plant. That overlying it was the fort's reservoir.



Fort Sasso da Pigna: Part of the very long access tunnel linking the accommodation complex with the guns

From here, a smaller profile tunnel runs east for some 700m to the gun positions. However, as the latter are at successively higher levels than the rest of the fort, the



Fort Sasso da Pigna: The slope shaft linking the access tunnel with the higher gun casemate level

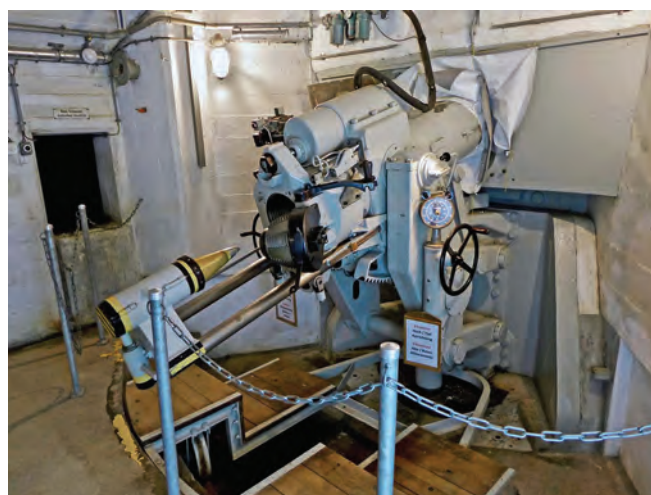
last section of this access tunnel is a steep slope shaft incorporating a funicular railway for ammunition and equipment. The fort's personnel had to use a flight of about 400 steps immediately alongside this.

At the top of this funicular, a passage leads off to secondary accommodation and another air filter room, both necessitated by the fort's extended layout. A machine-gun position is reached up a separate flight of steps to the south. The main guns are mounted in individual casemates excavated behind the rock face and linked to the main access tunnel by short spur tunnels. Opposite these, each gun has its own magazine, opening directly off a lobby area within the main tunnel.



Fort Sasso da Pigna: The entrance to the second magazine (West II). The standard interior is laid out as two narrow corridors formed by four rows of concrete racking, three compartments high, but not reaching the arched ceiling

Two magazines and guns (West I & West II) are located at this level, with a further pair (East I & East II) at a higher level again, reached by a second funicular, accessed from the lobby outside the first magazine. These latter guns, magazines, funicular and access tunnels are not publicly accessible, but may be presumed to replicate the lower set, with the addition of another machine-gun position at the eastern extremity of the fort.



Fort Sasso da Pigna: The 15cm 'bunker cannon' 42/46 gun on a parallel lever mount. This powerful gun was specially developed for fortress use

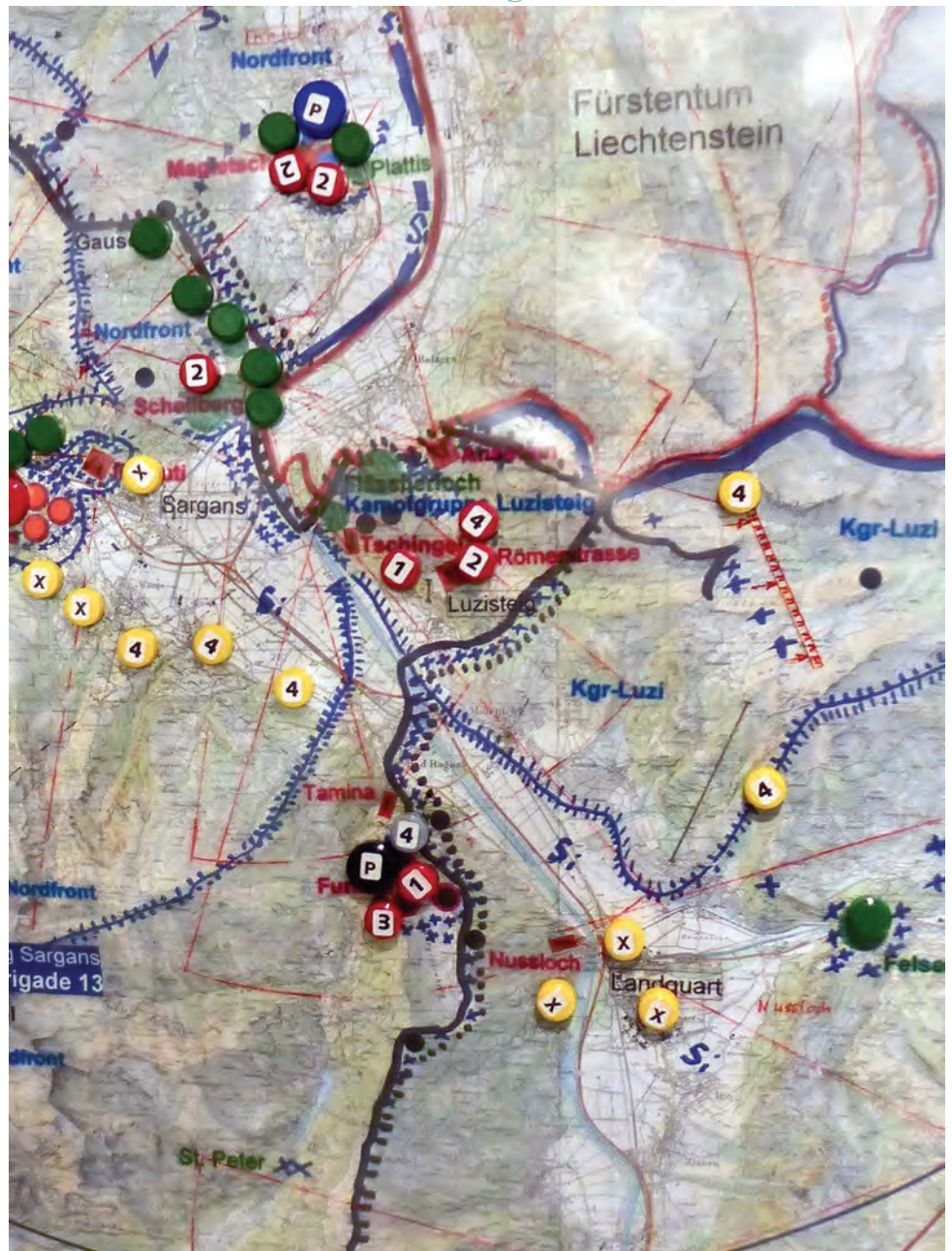
Fortress Sargans

The fort's main armament evolved during the planning and wartime operational periods. Initially, only two 10.5cm guns were envisaged, but soon it was proposed to supplement these with two 7.5cm guns. A further intended enhancement, to four 15cm guns, was thwarted by delivery problems, so initially four 10.5cm guns were installed, these being replaced by the intended 15cm guns within a year. In 1958 there was a proposal to install another pair of 15cm guns, but this was not implemented.

The fort was decommissioned in 1998 and has since been developed into a tourist attraction incorporating a crystal museum within the western accommodation complex.

Fort Gütsch

Fort Gütsch was the third of the three modern artillery forts, built between 1941–44 to update Fortress Gotthard. It mounted three 10.5cm guns in armoured turrets, together with five bunkered machine-guns. It was not visited internally [7], but its setting (at 2,300 metres, the highest 'modern' artillery fort in Switzerland) is spectacular and its camouflaged surface structures remain a sculptural delight. It was decommissioned in 1994.



Fortress Sargans: Part of an operational pin board in Fort Magletsch showing the position of the main forts, relative to one another, the Rhine Valley, and the pass they defended into the Alpine zone (to the west of Sargans). Magletsch is to the north, Furggels to the south, with the others mostly clustered around Sargans town



Fort Gütsch: From the evidence of the concealed casemate on the left-hand side, this elaborately camouflaged structure was probably a machine-gun bunker

Since the fortification of the Redoubt in the late nineteenth century, a vulnerability had arisen on its eastern flank as a result of the draining of the marshy Rhine Valley, which forms the border between Switzerland and Liechtenstein. The valley had now become a feasible invasion route into the eastern Swiss Alps. In defence of this, a new underground fortress complex was constructed near the border town of Sargans.

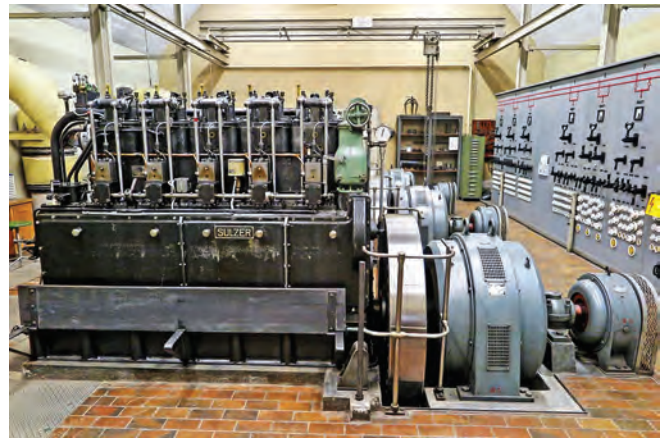
Starting in 1939, a group of (initially) six forts was built. Forts Magletsch, Kastels and Furggels mounted long-range 10.5cm turret guns [8]. Forts Schollberg

1, Passati and Ansstein had 7.5cm guns in casemates, 4.7cm anti-tank guns and machine-guns. Other forts were added later, principally Forts Schollberg 2 & 3 and Tschingel. This last was excavated over four levels, mounting 7.5cm guns firing south down the Rhine towards Furggels.

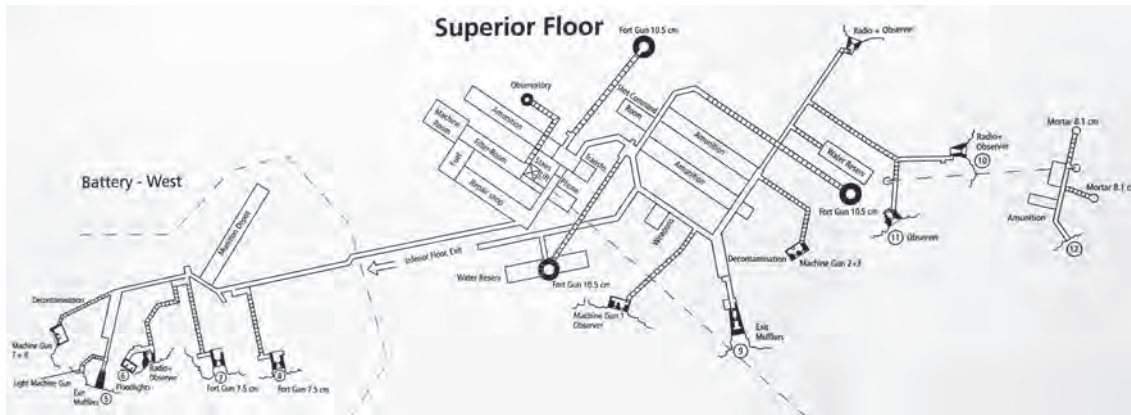
The interlocking fields of fire of these forts supported a network of anti-tank pillboxes and road blocks. Provision was made to inundate the valley floor, the pillboxes being built well above ground level so they would still command this water barrier.

Fort Magletsch

At the northern end of Fortress Sargans, excavated within a great rock outlier, lies the major artillery fort of Magletsch.



Fort Magletsch: The engine room with its three 200hp Sulzer diesel generators. Photo Clive Penfold



Fort Magletsch: Plan of the higher, operational level. Source: AFOM (Artillerie Fort Magletsch) brochure

This mounted three 10.5cm turret guns; four 7.5cm guns firing from casemates; and eight heavy machine-guns. The layout of the fort, which is built on two main levels (with the gun positions at various higher levels again) is complex.

but dog-legged service tunnels. Access to the eastern 7.5cm battery is gained from this level via a tunnel which forks into a number of branches after passing the common magazine.



Fort Magletsch: The ramp leading from the turntable chamber to the upper level of the fort

The main entrance tunnel, designed for lorries, leads to a turntable area. Beyond this, at the same level, lie the accommodation and service facilities, contained in a series of long chambers accessed from two parallel



Fort Magletsch: One of the 8.1cm mortars installed in armoured cupolas during the 1960s

Also leading off from the turntable chamber is a long ramp to the upper level of the fort (elsewhere there is also a lift and staircase). This upper level, the 'operational' part of the fort, contains three large magazines and the fort's fire control centre, as well as the power and filter plant rooms, workshop, reservoirs and fuel store.

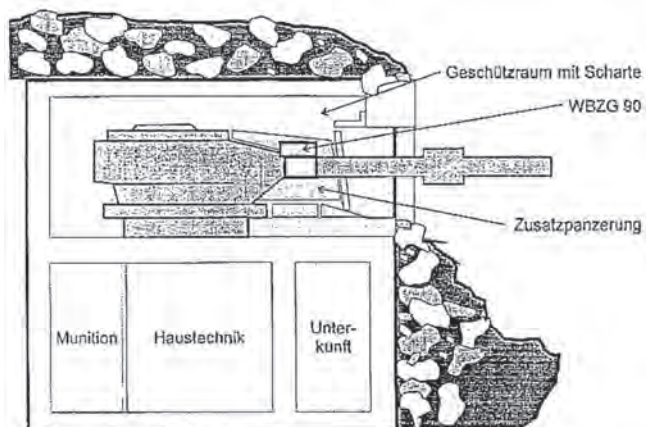
The standard long flights of stairs fitted with electrically-powered chain-driven ammunition hoists lead up to the three 10.5cm gun turrets. On one of these, temporary rails had been laid, demonstrating the method of moving a gun barrel from turret to workshop, or vice versa. Other stairs lead to machine-gun casemates and observation positions. The western 7.5cm gun battery is reached via a long tunnel from this upper level.

In the 1960s, two 8.1cm mortars were added in a small excavated extension to the fort. This is reached from an existing observation level via a vertical ladder in a circular shaft. The mortars were installed in armoured cupolas with only the muzzle exposed on the surface.

Fort Schollberg

The Schollberg complex, located within the bluffs on the western side of the Rhine Valley, comprised, from north to south, one artillery and two infantry forts. The most southerly, Schollberg 3 dates from the immediate postwar period and was constructed as an artillery fort but converted to an infantry work in 1959. Each work had its own, discrete, entrance, but the three were linked by long pedestrian tunnels.

In 1969, the total armament of the three forts comprised five 9cm anti-tank guns (the more powerful postwar successor to the original 4.7cm guns), three 7.5cm casemate guns and twelve assorted machine-guns, but this had been reduced to two anti-tank guns and nine machine-guns by the time the forts were decommissioned.



Centurion Bunker cross-section. "Zusatzpanzerung" is additional armour attached to the front of the turret; the bunker itself merely has an open firing embrasure.

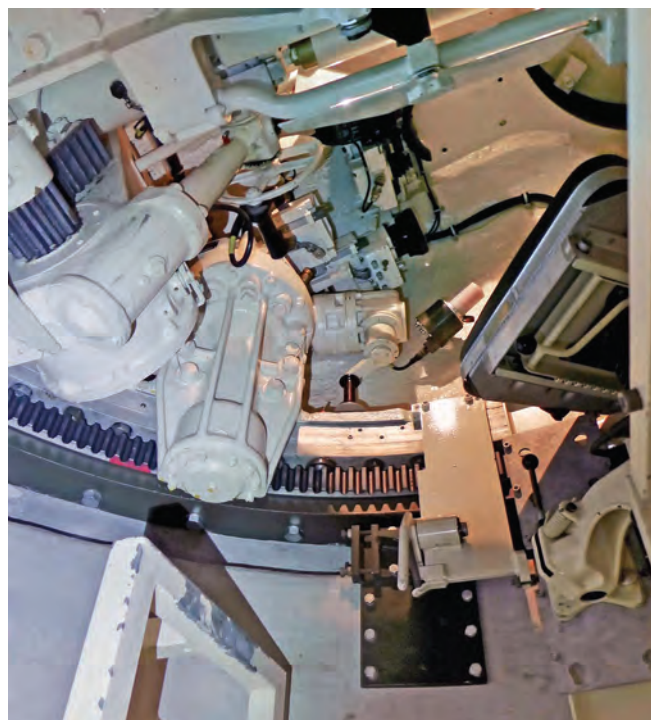
Source: www.schweizer-festungen.ch

Centurion Bunker

In the 1990s a number of Centurion tank turrets mounting 10.5cm guns became surplus. It was proposed that 100 or more of these would be installed in purpose-built bunkers as anti-tank guns. This ambition was

successively whittled down to just twenty. Two were allocated to Sargans, one being built just to the south of the entrance to Schollberg 3.

The bunkers are compact two-storey structures, accessed through a short side passage, protected by heavy blast doors. The upper level houses the turret and the lower the magazine, services and shelter for the crew of between six to eight men. They are generally embedded in a hillside, with only the casemate frontage exposed, as in the diagram. When not in use, the gun barrel was retired to a slot to one side of the embrasure, both of these apertures normally being closed by weather shuttering. The bunkers were declassified in 2003.

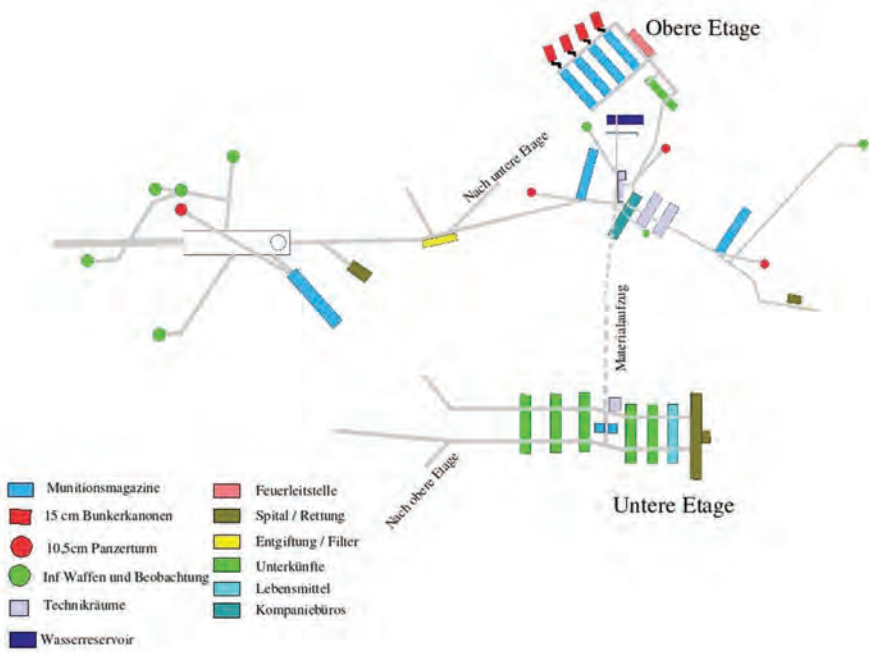


Centurion Bunker: Looking up into the turret from the lower storey of the bunker. The turret has two crew seats and only a very small supply of 'ready' ammunition; further supplies would need to be man-handled from the magazine

Fort Furggels

About 9km southeast of the town of Sargans, and 700m above the floor of the Rhine Valley, lies Fort Furggels, the largest and most heavily armed fort within the Sargans Fortress. This was built in stages between 1939 and 1947.

The fort's total manpower complement was 420, including 70 fortress infantry, and the supporting infrastructure was on a comparable scale. This encompassed the usual range of facilities including an engine room equipped with three Sulzer diesel generators, a fuel reservoir (two 100,000 litre tanks), water reservoirs (three tanks with a total volume of 1.35 million litres and a 'day reservoir' of 12,500 litres), workshops, kitchen; bakery and canteens, a hospital and accommodation. In all, the fort comprises 190 rooms and some 7.6km of tunnels.



Fort Furggels: Plan by Clement Dominik, 2006, reproduced under Creative Commons Attribution Share Alike Licence

As with Magletsch, access to the fort is by a (7.5t) lorry-size tunnel leading to a large chamber equipped with a road turntable. Furggels was also built on two levels although, in this case, the accommodation and support area is sited about 20m below the operational level. The two levels are connected by a sloping tunnel and by a materiel hoist with stairs alongside. The armament was installed in three phases, starting with two 10.5cm gun turrets, which were ready to fire in July 1940, followed by another pair, operational in May the following year. The turrets are accessed by the usual long straight flights of stairs equipped with the standard ‘paternoster’ ammunition hoists. Each has an adjacent magazine, separately accessed from the main tunnel.



Fort Furggels: The lorry turntable at the end of the main access tunnel into the fort. Photo Clive Penfold



Fort Furggels: These chickens are defended by a 10.5cm L52 39 turret gun



Fort Furggels: One of the magazines for the 10.5cm turret guns. The roof profile is characteristic of the concrete structures of this period built within excavated chambers. The later 15cm magazines had a larger, arched cross-section, similar to those at Fort Sasso da Pigna



Fort Furggels: This close-defence bunker is encased in a substantial pitched roof structure which convincingly resembles a barn

The fort was equipped with various armoured observation positions. Close-quarters defence was provided by an anti-tank gun and machine-gun casemates. These, and the 10.5cm gun turrets were camouflaged with superstructures to resemble farm sheds and barns.

In 1945, a major enhancement commenced with the excavation of a row of four casemates, destined to mount 15cm guns. Behind each of these, connected by a short dog-legged passage, was a large magazine. These guns, the biggest calibre installed in the Swiss forts (excepting the short-lived “Bison” project of the 1990s), did not become operational until 1946–47.

Fortress Saint-Maurice

Saint-Maurice, a key bridging point on the Rhone where it flows through a narrow defile, was a strategic position defended by a medieval castle and further fortified by Dufour in 1831. One of his infantry towers survives. Construction of the powerful Fortress Saint-Maurice, controlling access to the National Redoubt along the Rhone valley, commenced in the 1890s.

The main position was Fort Dailly, supported by the lower Fort Savatan, both operational in 1894. In 1911, these adjacent forts were supplemented by Fort du Scex, excavated within the cliffs on the western bank of the Rhone. This fort was extended in stages, up to the early 1950s. Fortress St-Maurice was significantly reinforced during and after World War II by the construction of Fort Cindey, a mixed artillery and infantry position.

Fort du Scex

The evolution of Fort du Scex, an artillery fort designed to provide supporting fire to Forts Dailly and Savatan, provides an interesting example of continued development over four decades.

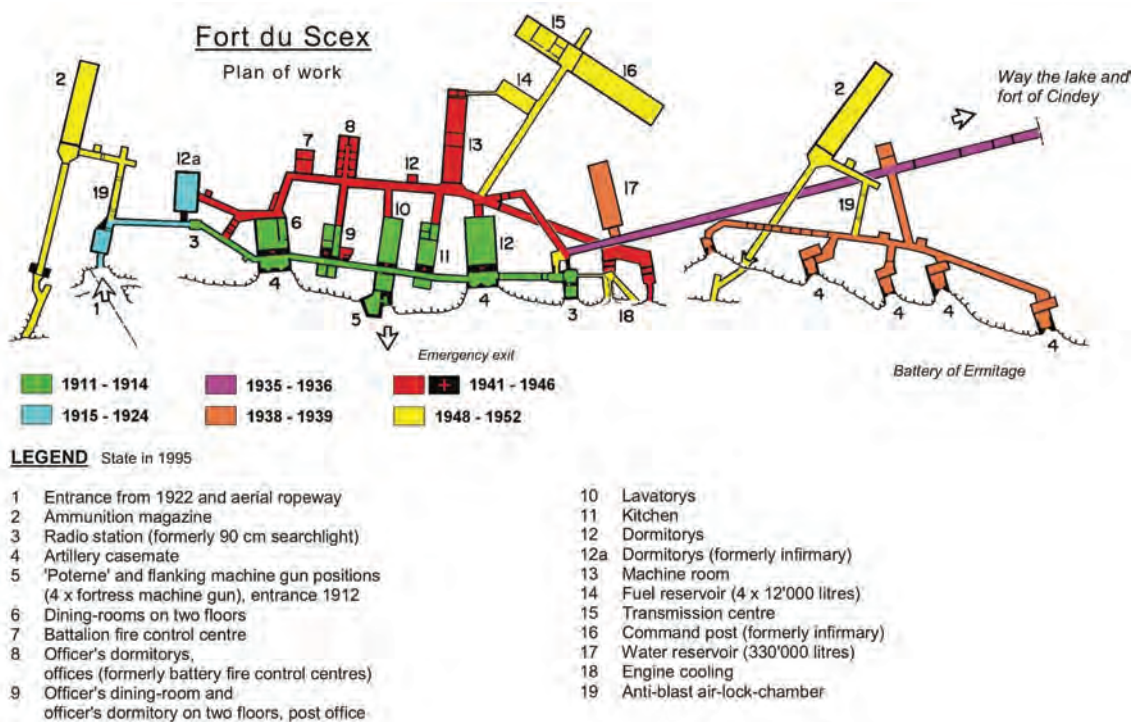
The original 1911 plan was quite simple. The centrally-located entrance, covered by a flanking machine-gun position, gave access to a spine corridor running within, and parallel to, the cliff face. This served two unusual double casemates, each equipped with a pair of 7.5cm guns and, at the fort’s extremities, two searchlights. Accommodation and messing facilities were provided in chambers mostly excavated further into the rock, opening off the other side of the corridor. In 1922 a new entrance was constructed to the south, served by an aerial ropeway, the original entrance becoming a ‘postern’ or emergency exit.



Fort du Scex: One of the 1911 double casemates for two 17.5cm L30 1903/18 guns. Photo Fortress Historique de St-Maurice

The immediate pre-World War II upgrading of the fort doubled its armament, adding four new 7.5cm single-gun casemates (the “Ermitage Battery”) located immediately to the north. Continued wartime construction involved the excavation of parallel tunnels and chambers behind

the 1911 works to provide for further accommodation and supporting infrastructure. In the exigency of the 1940s, it was normal Swiss practice to prioritise getting the gun positions built and operational before turning to the fort’s ancillary functions.



Fort du Scex, showing this early underground fort's development from 1911 to 1952. Diagram © 2011, Fortress Historique de St-Maurice, reproduced with permission

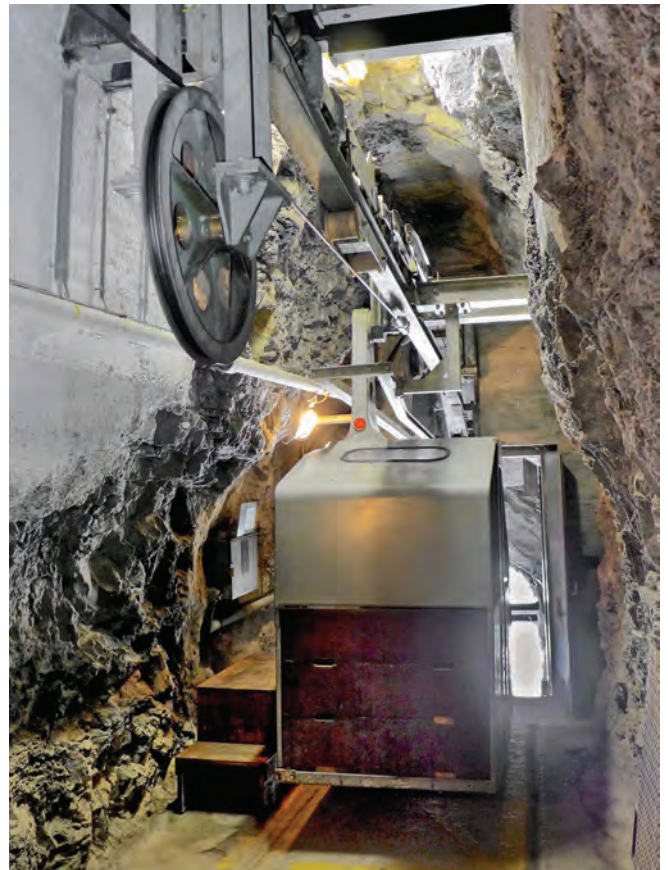




Fort du Scex: A 7.5cm L30 1903/22 gun installed on a lever mount in the 1938/39 "Ermitage Battery".

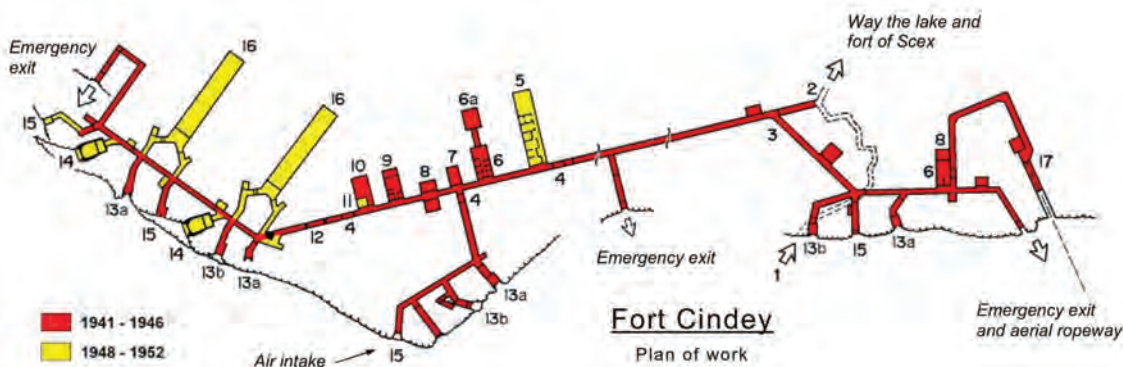
Photo Fortress Historique de St-Maurice

Post-World War II expansion added new magazines, command and control facilities and significant fuel storage: Fort du Scex also provided the power and communications for Fort Cindey. In 1984 it was converted to serve as a command post and was decommissioned in 1995.



Fort Cindey: The top of the aerial ropeway at the point of entry to the fort

Fort Cindey



Fort Cindey: Diagram © 2011, Fortress Historique de St-Maurice

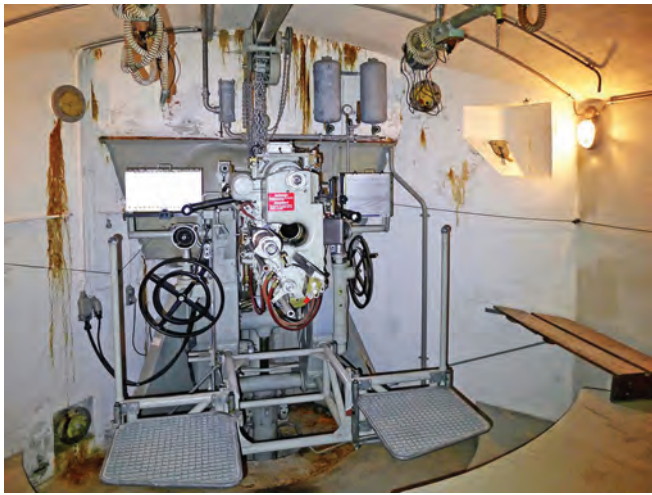
List of references

- | | |
|--|---------------------------------------|
| 1 Entrance to «Grotte aux Fées» | 10 Rations magazines, enquiries |
| 2 Entrance to the fort | 11 Gunnery command |
| 3 Access to the northern gun-positions | 12 Anti-blast air-lock-chamber |
| 4 Anti-poison-gas air-lock-chamber | 13a Infantry casemates (antitank gun) |
| 5 Hospital | 13b Infantry casemates (machine gun) |
| 6 Men's sleeping-quarters | 14 Artillery casemates |
| 6a Water-reservoir | 15 Observation post |
| 7 Kitchen | 16 Ammunition magazine |
| 8 Filter room | 17 Aerial ropeway |
| 9 Dining-hall and head-quarters | |

Fort Cindey was built in two phases, the latter postwar; it remained in service until 1985. A kilometre to the north of Fort du Scex, and similarly excavated within the cliffs, it was linked to the earlier fort by a long gallery connecting into the even-longer passageways of a natural cave system. An aerial ropeway for the haulage of materiel was provided at the northern extremity of the fort.

The armament was more powerful and modern than at Fort du Scex: two 10.5cm L52 guns – as used in the turret forts, but here installed in casemates in an anti-tank role, supplemented in the 1950s by four 9cm anti-tank guns.





Fort Cindey: 10.5cm L52 39/46 gun on parallel lift carriage mount



Fort Dailly: One of the 10.5cm L42 39 guns on a stand carriage mounts of the new Battery Dailly Nord

Fort Dailly

As originally built, Fort Dailly comprised mainly open positions for guns, howitzers and mortars, relying on its considerable altitude for protection from counter-battery fire. Krupp 15cm field guns initially provided the heavy artillery, supported by batteries of various other calibres, updated over time.

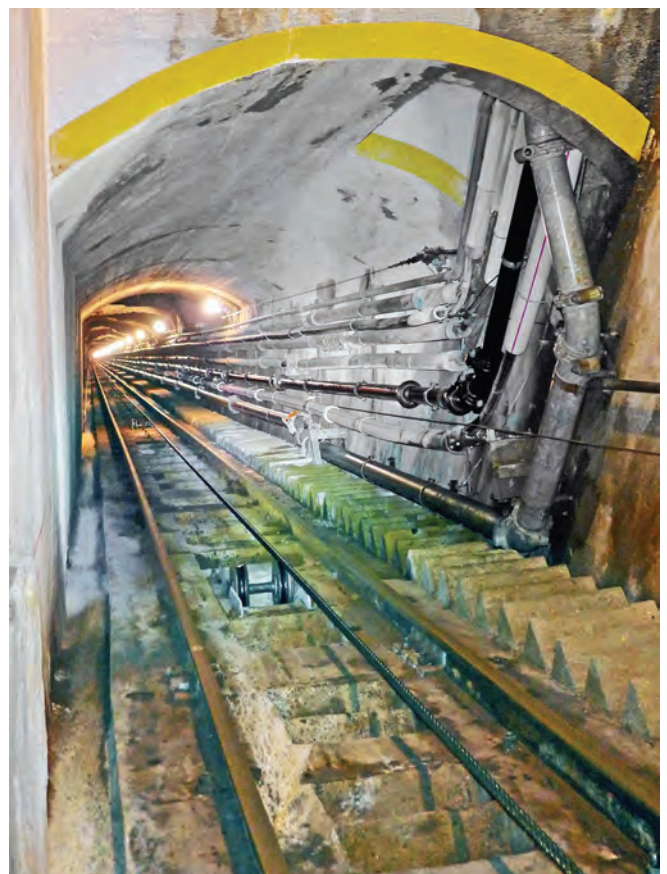
Some of these guns were protected by concrete casemates, armour, and/or were stored in rock-cut shelters and moved into firing position along protected rail tracks. All this was to change in the 1930s modernisation.

At Battery Rossignol, at an altitude of 1,400m, a gallery, of sufficient dimensions for towed 10.5cm artillery, was driven into the mountainside. Tunnels branching off from both sides led to ten armoured casemates for these guns, grouped in three geographically-orientated batteries: Buits (four guns to the north); Plex (four guns to the south); and Rosseline (two guns to the east). Three main magazines were excavated on the south side of the gallery between Rosseline and Plex.

The 1946 disaster

On 28 May 1946, these magazines, containing a total of some 5,500 shells, exploded, wrecking Battery Plex and doing considerable other damage. The cause of the explosion was thought to be the decomposition of the nitrocellulose propellant. This disaster led to a comprehensive modernisation of the fort.

Battery Plex was abandoned and sealed off, being replaced with Battery Dailly Nord, comprising three 10.5cm L42 guns mounted in spacious new casemates. These were excavated further to the west along the main gallery, and each was reached via a dedicated magazine. NCB (Nuclear, Chemical and Biological)-protected underground facilities for 650 men were constructed, and the fort was linked to the much lower-lying Fort Savatan by an underground funicular railway. Obsolete weapons were removed and new ones installed. These included the (ultimately ubiquitous) 8.1cm (and later



Fort Dailly: The underground funicular linking the fort to Fort Savatan. This is 560m long, and descends 388m, taking between 7.5 minutes (payload 1,800kg) and 12 minutes (maximum payload 3,000kg)

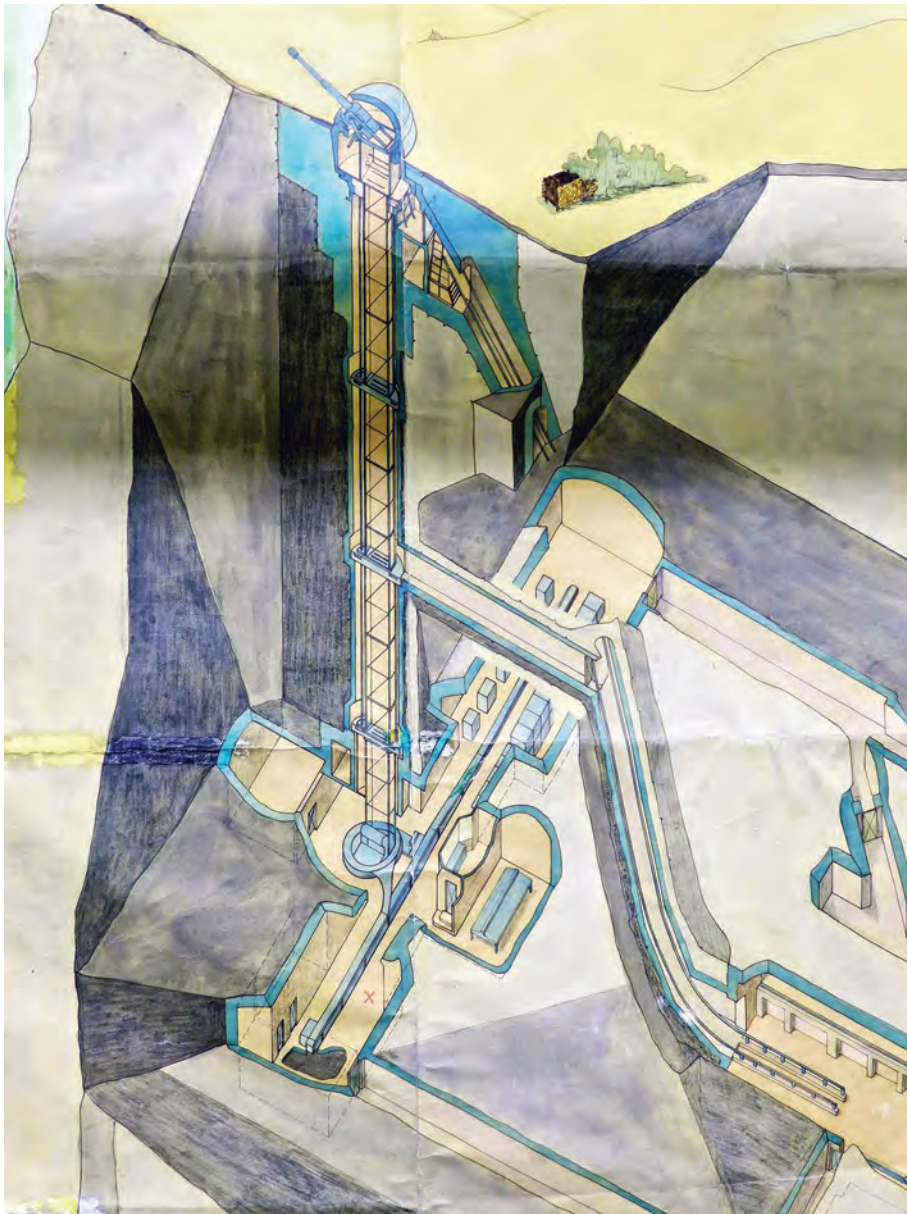
12cm) mortars and, in batteries T1 and T2, two unique 15cm turret gun installations.

The mountain battleship

On the surface (at 1300m and 1500m, respectively) these 15cm gun turrets merely resemble larger versions of the 10.5cm turrets of other Swiss forts – T1 complete with faux shed camouflage. What lies beneath them is spectacularly different.

With each gun capable of a sustained rate of fire of fifteen rounds per minute (and 22 rpm in bursts) they





Fort Dailly: Part of a sectional diagram of the 15cm gun installation displayed within the fort. The passageways on the right-hand side lead to the magazines. The room at the bottom right-hand corner is the workshop at the foot of the turret funicular

required an automated ammunition supply. The solution was as close as Switzerland ever came to building a battleship – or at least its barbette. Fifty metres below each turret a suite of chambers was excavated to provide a fire control centre, ammunition preparation and handling rooms, plant space, a workshop and, at a suitable remove, two magazines.

The turret was linked to this subterranean complex in two ways. Ammunition was raised to the gun via an ammunition hoist set within in a vertical shaft; this also served to return the spent shell cases. At the foot of the shaft a large ammunition carousel was installed. This was located to one end of the ammunition handling room.

A long conveyor running the length of this room linked the carousel with the ammunition preparation area, where the required charges were loaded into the shell cases and mated with the relevant shells and detonators before being despatched to the gun.

Men and equipment reached the turret via a dedicated funicular railway installed in a separate, inclined shaft leading off from a large workshop. The man/materiel cage was quite small, but the system had the capability to transport gun barrels: a spare barrel with



Fort Dailly: The ammunition carousel at the foot of the vertical shaft to the turret



Fort Dailly: The workshop for the T1 15cm gun installation with the base station of the turret funicular



Fort Dailly: The ammunition carousel at the foot of the vertical shaft to the turret Fort Dailly: The shell conveyor for T1, viewed from near the carousel, with the ammunition preparation area at the far end

transportation cradle was still stored in the workshop, adjacent to the foot of the funicular track.

Design of these two installations began in the 1950s but they were not operational until 1962, thereafter remaining in service until 1994. They were intended to be the precursors of others, but no more were built: the immense construction cost and relative complexity of the system mitigated against them. Instead, the military turned to self-contained ‘mono-bloc’ bunkers.

Conclusion

The value of fortifications which have not come under assault is always a matter of conjecture. In World War II, Switzerland invested considerable resources in fixed defences, as well as promptly mobilising some 430,000 militia troops. In parallel, pragmatic Swiss diplomacy and a flexible trade policy (the latter meeting Switzerland’s essential economic requirements as well as balancing the conflicting demands of the Axis and Allied powers) reduced the strategic benefit of invasion to the Axis.

A German invasion had been a real option. Hitler appeared to regard Switzerland somewhat contemptuously as both a nuisance and an anachronism. Strategically, Switzerland controlled vital transport routes linking Germany and Italy. More generally, Nazi ideology envisaged that the Third Reich would expand to encompass any German-speaking territory.

Invasion plans were drafted and refined, becoming *Operation Tannenbaum* (‘Christmas Tree’). This envisaged a joint German and Italian offensive involving

some twenty or more divisions. Interestingly, it avoided an attack on Fortress Sargans which was considered particularly difficult.

The Swiss forts were well-entrenched, but in the early 1940s few were fully operational. Nor were they particularly sophisticated in critical areas such as the emplacement and protection of guns, ammunition transport and handling, or casemate ventilation. That said, the Italian attack on France in June 1940 had made singularly little headway against the French Alpine fortifications before the armistice terminated the campaign. However, it is difficult to see how a largely-militia Swiss army, with little in the way of heavy weaponry or air support, could have prevailed against the battle-hardened German war machine.

Notwithstanding this, the Swiss establishment clearly considered that the nation’s investment in fortification before and during World War II had been worthwhile. It continued to develop these defences, not only throughout the Cold War, but for the rest of the twentieth century.

Most of the conventional forts remained in commission until the mid-1990s and successive generations of twin-12cm mortar installations were built over the forty years from 1959 – long after most other western powers had eschewed fixed artillery fortifications [9]. The ‘state-of-the-art’ bunkered 15.5cm “Bison” gun battery was developed as late as the mid-1980s and a small number constructed during the 1990s. Only within the present decade has a political decision been made to cancel these programmes. Both weapons systems remain classified.



Extinct species? One of the 1990s “Bison” 15.5cm gun batteries. This example is in a publicly accessible area with no restriction on photography. Photo Clive Penfold

Sources

All photographs are by the author unless specified otherwise.

J.E. Kaufmann & H.W. Kaufmann, *The Forts & Fortifications of Europe 1815–1945: The Neutral States*, Pen & Sword, 2014. This is the most accessible English language text.

A few of the Swiss preservationists have produced well-





A mural of Swiss soldiers, painted on a sloping ceiling in Selgis Command post

illustrated German or French language books on the fort or groups of forts in which they have an interest. An excellent general volume is:

Peter Baumgartner & Hans Stabler, *Befestigtes Graubünden: Wolfe im Schafspelz*, Verlag Desertina, 2016, ISBN 978-3-85637-485-3

Various Swiss websites list technical information on the forts and their armament. The museum sites also mostly have websites. I found the following sites particularly useful:

www.festung-oberland.ch

www.schweizer-festungen.ch/festungen.htm

www.forteresse-st-maurice.ch

www.ar.admin.ch/de/armasuisse-immobilien/historische-militaerbauten.html

I have also drawn on Wikipedia and particularly on the FSG/CDSG Switzerland Study Tour Notes issued to participants.

Notes

[1] A “National Redoubt” is a core, defensible area of national territory that the military would seek to hold against an aggressor in the event that other, less defensible territory had to be relinquished. Its ultimate purpose is to preserve, at least in principle, national identity and sovereignty until such time as these can be re-established across the whole country. Belgium and The Netherlands were two other neutral nations that sought to create such strongholds in the 19th and 20th centuries, but neither withstood the assaults Germany launched on them.

[2] The Treaty of Westphalia, 1648, which ended the Thirty Years War, recognised the independence of the Swiss Confederation, the origins of which went back some three and a half centuries. The Confederation survived until 1798 when French republican armies invaded the Swiss cantons, imposing the Helvetic Republic and fighting against Austro-Russian forces campaigning on Swiss

territory between 1799–1800. The revolutionary ideas imposed by the French created widespread resentment. Uprisings eventually led to the collapse of the Helvetic Republic, resulting in Napoleon’s restoration of the Swiss Confederation in 1803. The 1815 Congress of Vienna, which set Europe’s post-Napoleonic political framework, guaranteed the neutrality of Switzerland.

[3] Guillaume Henri Dufour (1787–1875) was an engineer and army officer who was elected to supreme command of the Swiss army on four occasions of national crisis. Outside Switzerland, he is most known for having presided over the First Geneva Convention regarding the treatment of the wounded in war and establishing the International Red Cross.

[4] Vichy France retained a short neutral border with Switzerland running east from Geneva along Lac Lemman and a similar distance south to near Chamonix/Mont Blanc. This was lost on 11 November 1942 when this part of France was occupied by Italy.

[5] For a good assessment of the Belgian forts, and account of their destruction by German heavy artillery, see Clayton Donnell, *Breaking the Fortress line 1914*, Pen & Sword, 2013.

[6] According to JE & HW Kaufmann (op cit), Gotthard Fortress comprised a total of seventeen artillery forts, although, spanning the period from 1887 to 1943, these encompassed various degrees of obsolescence. The system of forts, in turn, was supported by a network of detached bunkers, pillboxes, observation positions, anti-tank barriers and roadblocks.

[7] An excellent set of photographs of Fort Gütsch, including its labyrinthine interior, is available online at <http://www.lignemagnot.com/ligne/suisse/uri/gutsch/index.htm#10>

[8] By late 1940 Fort Magletsch mounted three 10.5cm turret guns, and Forts Kastels and Furggels two each. By mid-1941 Kastels had received another one and Furggels another two.

[9] Scandinavia and Spain are obvious exceptions. Sweden built five coastal defence forts armed with Bofors 12cm gun turrets in the 1970s and early 1980s, and Norway three a decade later. These remained in commission until the end of the century. Spain boasted coastal batteries mounting, inter alia, exceptionally long-lived Vickers 15-inch guns, the last of which was retired only in 2008.

Standedge Tunnels - Sub Brit visit

Phil Catling



Tunnel End cottage (now a tea shop) at the Marsden end of the tunnel and the SubBrit boat. Photo Bob Clary

On a rainy day in June, a motley crew of happy Sub Britters gathered in the Yorkshire countryside for an organised trip through the ‘Longest, Highest and Deepest’ canal tunnel in Britain. Travelling from Manchester Piccadilly on the Huddersfield train meant that just before Marsden station, the coaches flew through the double-track railway tunnel, currently the border between ‘God’s own county’ and the megacity of Greater Manchester, in just three minutes.

The same trip through the hillside takes over two hours by tug and powered passenger boat. Although that’s a definite improvement on the regular four-hour trips of the past, when legging the walls was the only way to move heavily loaded narrow boats through the dark.

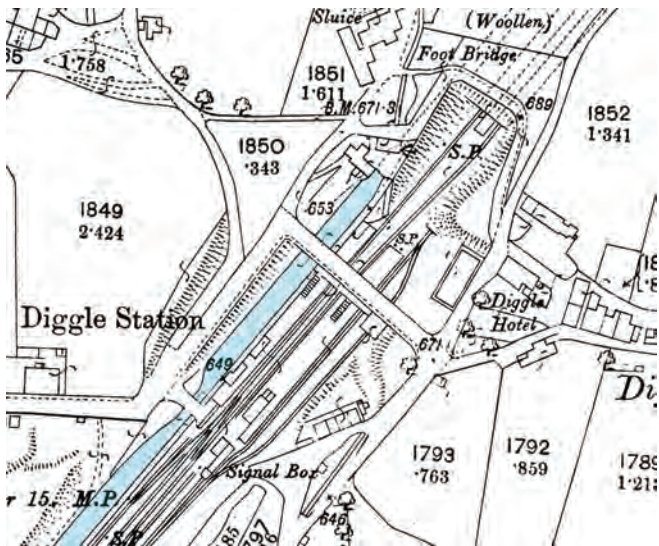
The moorland above the tunnels is the location of an ancient Pennine crossing point, the Roman road between York and Chester. As trade and travel developed, the routes across the bleak moorland became more advanced, with packhorses taking the place of marching legionnaires. Tracks and paths followed with the first true roads driven across the top in 1760 and 1791.

Act of Parliament

At the same time, plans were being made to revolutionise the movement of goods and raw materials in the district with the development of the Huddersfield narrow canal. Started in 1793, the huge lump of Standedge was identified early in planning as an obstacle on the route. The first Act of Parliament authorising a tunnel through the hillside was granted in April 1794.

Plagued by difficulties with planning, engineering and overrunning costs, the canal tunnel took 16 years to construct, with a number of lengthy delays. Digging started from both ends of the planned tunnel, with a number of shafts also driven down from the surface. Many of the shafts were subsequently abandoned as work underground moved faster than they could keep up. The major shaft at Redbrook, roughly halfway along the canal route, was also pressed into service as horizontal drifts were sent out to meet up with the shafts coming from each end. Problems were almost immediate with far more water in the workings than expected. The over-optimistic report on the strata below the hill – originally estimated to need no additional support or lining – caused many prospective companies and contractors to founder.

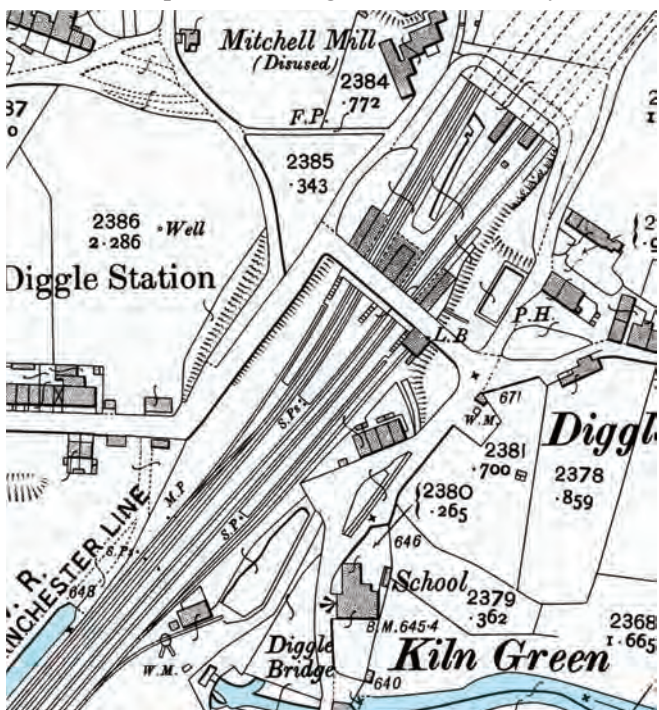




1890 1:2,500 OS map shows the Diggle canal portal as built alongside the two parallel single-track railway tunnels completed in 1848 (left) and 1871 (right).

No towpath

Engineers Benjamin Outram and Thomas Telford worked on the project which finally opened to traffic in 1811. The design of the tunnel continued to cause problems, with the lack of a towpath and the need for ‘legging-through’ of boats making the tunnel a bottleneck on the canal trade between Huddersfield and Ashton. Although crossing points deep within the tunnel had been included in the design, they proved impractical and single-direction travel was required, slowing trade considerably.

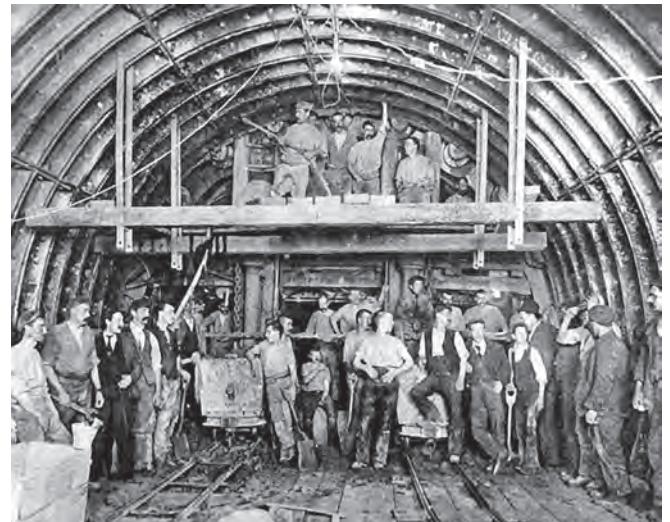


1904 1:2,500 OS map shows the Diggle portal after the canal tunnel was extended in 1893 to accommodate the new double-track railway tunnel

From Wikipedia: “The tunnel had cost £160,000, making it the most expensive canal tunnel to have been built in Britain. It was also the longest, deepest and highest. The tunnel was 5,445 yards (4,979 m) long, 636 feet (194 m)

underground at its deepest point, and 643 feet (196 m) above sea level. It was extended at the Marsden end in 1822 by 11 yards (10 m) when Tunnel End Reservoir’s overflow was diverted over the tunnel mouth.

“The tunnel was also extended at the Diggle end in 1893 by 242 yards (221 m) to accommodate the 1894 rail tunnel. The extensions made the tunnel 5,698 yards (5,210 m) long. A survey carried out before restoration using a modern measuring system gave the length as 5,675 yards (5,189 m) which is the accepted figure.” https://en.wikipedia.org/wiki/Standedge_Tunnels



Construction of the third Standedge rail tunnel c.1893

The canal tunnel was never a runaway success, although managing to pay a dividend to shareholders on a number of occasions. The competing Rochdale canal was better constructed, wider and did not have the bottleneck of a long tunnel along the route. The tunnel actually came into its own as the railways powered through the country, linking trade and cities much faster than the canals.

Arrival of the railways

By 1846 the canal tunnel was being regularly bypassed and plans were afoot for a new trade route through the Standedge hillside. The Huddersfield and Manchester Railway bought the tunnel in 1846 to remove spoil and provide air for their new parallel and slightly shallower single-track tunnel. The ‘Nicholson’ tunnel was completed quickly and safely, taking just two years to complete, a full five years faster than the comparative Woodhead tunnel, despite Woodhead being shorter and both being constructed by the same engineer, Thomas Nicholson.

All spoil was removed, and materials brought in, through the canal tunnel, meaning no new shafts were required from the surface. This single track was soon overwhelmed by traffic and a second tunnel was in the planning stages before the first was completed.

Adits driven below the Nicholson tunnel meant that it could be kept in operation while construction of the ‘Nelson’ tunnel proceeded. Again, the canal tunnel was invaluable in removing spoil and bringing in materials.

By 1871 there were two railway tunnels and the canal tunnel in operation below the moorland.

Even these three tunnels couldn't keep up with demand and in 1890 plans were put in place for a new tunnel, double track, shallower than the existing ones and crossing the canal tunnel in two locations. This meant the extension of the canal tunnel at the Diggle end by a substantial 221 metres, to allow the new tunnel to cross above.

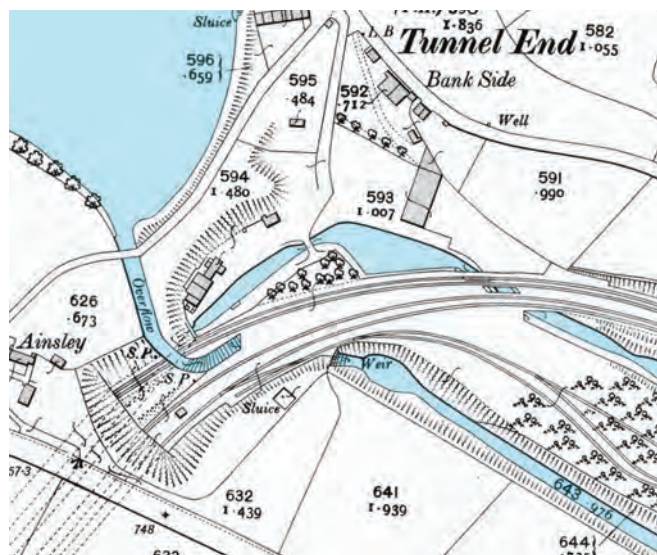
Disused tunnel available for emergency use

The new tunnel was almost the end of the canal tunnel as large amounts of gelignite blasting caused roof falls and damage, and meant brickwork supports needed to be added. Built in just four years, the double-track tunnel is still in constant use, with six trains per hour between Manchester and Huddersfield using the tunnel. The two single-track tunnels went out of use in 1966 and 1970 respectively, and the centre 1848 tunnel is used for safety access to the canal tunnel and the Nelson tunnel. Graded for road traffic, the Nicholson tunnel can be used by fire appliances and ambulances.



Looking southwest towards the Marsden end of Standedge Tunnel. The single-track 1871 (left) and 1848 (right) railway tunnels are on the left with the 1893 twin-track tunnel to their right. Between the tunnels, the overflow from the Tunnel End Reservoir is seen. The canal tunnel was extended by 11 yards in 1822 when the overflow was diverted over the tunnel mouth. The tunnel mouth with a bridge across it is seen to the left of Tunnel End cottages. Tunnel End Footbridge No 62 is on the right with part of Tunnel End Winding Hole in the foreground

and mills on the other, kept the tunnel in use. The last commercial boat travelled through in 1921, although maintenance was continued until 1944.



1904 1:2,500 OS map shows the Marsden end of the tunnel. The Tunnel End Reservoir overflow channel descends in a staircase between the two single tunnels and the twin tunnel. The canal tunnel portal is seen between the staircase and Tunnel End cottages. To the west is the Tunnel End Winding Hole with the transhipment warehouse on its north side

The canal tunnel did not long survive the coming of the railways, experiencing a huge decline in narrowboat traffic almost immediately. Only the loyalty of a small number of carters, moving large shipments of raw materials from one side of the moorland to factories



In 1961 and 1962 this boat took groups of canal enthusiasts through the tunnel. In time, however, parts of the roof became unstable and some sections collapsed, making through navigation impossible.

The Diggle portal is seen in this view.

With the withdrawal of regular work on the tunnel linings, roof falls were common and the canal became a danger very quickly. Except for trips by canal enthusiasts in 1948 and 1961, the tunnel was closed by large iron gates and remained unused until plans in the 1990s to restore and reopen the entire Huddersfield narrow canal.

Canal tunnel restoration work

Surveys of the tunnel showed significant damage, with the shallow-draft survey boat going aground in a number of places, most disturbingly deep in the tunnel near the original Redbrook workings. The worst of the falls were cleared and rock bolts sunk in the bare rock, then covered by Spraycrete to make the ceiling safe. This gives a unique feeling to travelling the tunnel as you move from brick to Spraycrete to bare rock to wood above you.



*Standedge Tunnel's Marsden portal in 1982.
Photo Nick Catford*

In 2001 the canal tunnel reopened to traffic although it took a number of years to work out a functioning pattern of travel. The narrowness of the tunnel meant British Waterways required that all boats be navigated empty, linked together and pulled by tugs. This led to delays and complaints and since 2009 boats can travel through under their own power, as long as they are chaperoned by an experienced guide.

The trans-shipment warehouse at the Marsden end of the tunnel was opened into the award-winning Standedge Tunnel Visitor Centre while Tunnel End Cottage is now a tea shop and café for visitors waiting to enter the tunnel. The tunnel can be visited for short trips daily, which enter the Marsden end and travel a short distance before coming back out the same way. Sub Brit on the other hand was treated to a much longer visit. We also benefited from having Standedge tunnel expert and Trevor Ellis, the author of *The Standedge Tunnels*, as our guide.

Sub Brit Visit

In the first part of this site visit report, we looked at the history and engineering of the four tunnels driven through the Standedge moor in Yorkshire during the nineteenth century: three railway tunnels and a canal tunnel. In June 2019, Sub Brit members were treated to an extended visit through the canal tunnel, including foot visits to the two unused railway tunnels. In addition we were treated to a sight that Trevor Ellis himself has only seen twice in over thirty years travelling the canal tunnel – a train.

The Sub Brit group was split into two groups for the visit, with group one travelling from Tunnel End at Marsden



Marsden end portal. Photo Bob Clary

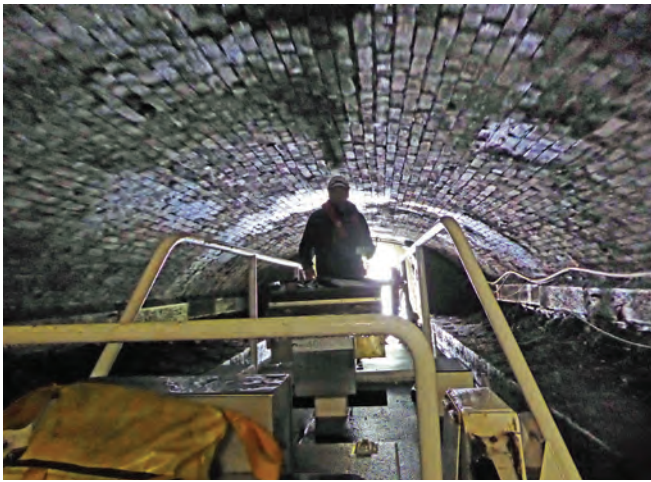


Dingle end portal showing extension added when the double-track railway tunnel was added. Photo Bob Clary

through to Diggle, then returning by local taxi. The second group convened at Tunnel End, before heading over the moor to Diggle to meet the boat. The trip across the moor meant we were able to see the landscape and put some of the difficulties of constructing the tunnels into perspective.

The Marsden end of the tunnel has a Visitor Centre and café which was a welcome sight in the watery sunshine. A short walk along the towpath from Marsden station, the transshipment warehouse and Tunnel End cottages are well restored, although the heritage centre was looking dusty and the dock inside needed clearing of rubbish. For a cutting review of the Heritage Centre and the difficulties in development and management, see Trevor Ellis' book *The Standedge Tunnels*, pp 94–95.

The Marsden end of the tunnels has a number of excellent information boards and offers a view of the three railway tunnel portals, with the added bonus of six Manchester to Huddersfield trains traversing the double-line tunnel per hour. The three portals, along with the spillway for the original Tunnel End reservoir, which leads water over the twin-track tunnel entrance, make for a stunning image. On arriving at an industrial car park at Diggle, the Sub Brit group was treated to the first view of our ride for the trip, a specially built narrowboat, with windows down



Brick-lined entrance to the canal tunnel. Photo Bob Clary
each side, glass panels in the roof, a toilet on board, and seats down each side of a central aisle.

The boat is steered from both front and back, with two helmsmen. This is due to the narrowness of the tunnel and the awkward angles of certain sections, with narrowboats regularly being damaged against the sides or wedged in the tunnel during use. The purpose-built narrow boat is festooned with lights and has a feature not usual on Sub Brit trips – a roll cage of bars encasing the open areas at front and back.

Each member of the group was issued a hard hat with chuckles from the guides as the usual Sub Brit variety of personal helmets, bump caps and ancient hard hats were produced from bags. As we jockeyed for seats, the guides explained safety rules which included no heads out the windows and keeping fingers clear of the bars, as the boat was liable to thump with some force against the tunnel wall with no warning. These seemed a little redundant from our seats, safe behind glass.



Sub Brit members on the specially adapted canal boat, with roll cage and glass ceiling. Photo Gerald Tompsett



1790s brick lining giving way to rock-cut tunnel; the space on the left of the photo is an emergency adit originally dug to remove spoil and waste from the Nicholson tunnel.

Photo Gerald Tompsett



Iron revetments in the roof of the canal tunnel.

Photo Gerald Tompsett



Abandoned adit showing the amount of water draining down into the tunnel. Photo Gerald Tompsett

History lesson

As we headed into the tunnel, we were treated to a quick history lesson which included demonstration of the twist hand-drill used to dig the original tunnel, and an explanation of the difficulties in construction. As we entered at the Diggle end, we started with the extension

built in 1890 to allow the new railway tunnel to cross the canal. This section is mixed iron revetment, brick and reinforcing rings added after the tunnel was made unstable by blasting.

The lights and roll bars soon showed their use as we bounced off each wall of the tunnel before moving into a rhythm. Perhaps a communication device between the front and rear drivers would be a useful addition! The reflections of the windows and the glare of spotlights posed a difficulty for photographers at this point, with the best view being over the driver's shoulder as he sat in the open front section of the boat.



*Victorian brick reinforcing arches, added after blasting for the twin-track tunnel damaged the roof.
Photo Gerald Tompsett*

Moving deeper into the tunnel we came across evidence of the rock strengthening work carried out in the 1990s. Fallen rock was cleared from the floor of the tunnel, rock bolts fitted above, and Spraycrete fixed to a retaining net. Although safe to visit now, and left a natural grey, the Spraycrete is not the most interesting of views.

The speed of the boat heading through the tunnel also meant the opportunity for photographs in focus was a trifle limited. Due to lack of communication in the tunnel, for each through trip the boat is shadowed by a van, driven along the adjoining Nicholson railway tunnel. At regular adits we would see a flash of the van keeping pace with us and reporting to Tunnels end that we hadn't sunk or lost power.

As the viewpoints were limited, it was decided to offer turns using the forward seats to see out of the front of the boat. This led the guide to finally explain all the safety gear and precautions – we were welcome to move around the boat, use the front and rear standing sections and take as many photos as we liked with no glass in the way!

A general exodus to these areas meant that the centre section was practically abandoned for the rest of the trip. As the guide stayed at the front of the boat, answering questions and explaining the tunnel network, it was lucky that the group on the rear platform, comfortably holding six or seven of us, were with Trevor Ellis.



*Emergency access adit, showing modern reinforcements.
Photo Gerald Tompsett*

Trevor, the expert on the tunnel network, and the author of the definitive book on the tunnels with decades of experience, made an engaging guide, leaping onto the platforms, seating and steps and enthusiastically pointing out highlights we might have missed. Refusing a helmet as he 'hadn't banged his head yet, and didn't plan to now', he gave an unvarnished and excellent commentary. The experience outside the glass was quite different, with the smells, sounds and ambience of the tunnel (and occasionally the engine) pressing in on us. Regularly throughout the trip we heard a call of 'water' and dodged quickly into the covered section to avoid gouts of rainwater falling from the shafts above and drainage from the active railway tunnel.



Rock-cut tunnel; visible on the ceiling are the long lines driven by the miners' hand drills. Photo Gerald Tompsett



Original brick lining from the 1795 tunnel work.

Photo Gerald Tompsett

The walls of the tunnel changed regularly from iron plates, brick lining, bare rock, brick ring reinforcements and Spraycrete, but the most interesting to me were the wooden sections. These original covers were added at the bottom of shafts from the surface to allow water and fresh air to reach the tunnel. They are huge chunks of timber, solid and secure despite their age and the ravages of the atmosphere deep under the hill.

Other wooden structures fill the voids left by the construction of the double-track tunnel, above and to the left of the canal tunnel for most of its route, where spoil was dropped down into barges for removal.

Rare sight

The regular trains passing through the railway tunnel are loud, driving a cushion of air before them and shaking the canal boat as they rattle past. We were lucky to be treated to a sight so rare that Trevor had only seen it once before in all his years in the tunnel. As we passed one of these open sections we coincided with a train blasting past from Marsden to Diggle. Clearly visible were the lit windows of the carriages, with unsuspecting passengers unaware they were on view. The train passed in just seconds, leaving a retina imprint as evidence.



The safety adit, looking back at the canal, showing the boat used by Sub Brit to traverse the tunnel. Photo Adrian Armishaw

As we travelled through the tunnel we saw many adits, some unrestored and some beefed up as emergency exits in case of difficulties. These adits were driven out from the canal tunnel to construct the two single-track railway tunnels running alongside. Used for the removal of rock and spoil, they allowed the rapid digging of firstly the Nicholson tunnel and later the Nelson tunnel.

The Nicholson tunnel was amazingly completed five whole years faster than the comparable Woodhead tunnel. The adits are large and multi-levelled, with the emergency ones having lighting, boat egress steps, and communications with the surface.

Sub Brit gets special permission

Usually access to the adits is strictly restricted and not allowed on regular boat trips through the tunnel, even the extended one we were on. However, as we were experienced underground visitors, and we had Trevor with us, special permission was obtained for the group to leave the boat and visit one of the adits.

The brightly lit adit with its concrete stairwell and emergency telephone contrasted with the bare rock above and filthy soot-covered brickwork on the walls. Along the floor drained a significant amount of water and silt from a small crawl-sized brick arch leading through under the Nicholson railway tunnel.

As trains were already using the first tunnel as construction commenced on the second, all spoil was removed through small access adits driven under the live trains. These small adits now drain the further Nelson tunnel into the canal. We were cheerfully offered the chance to crawl through but the amount of very smelly mud dissuaded even Sub Brit from a belly scrabble.



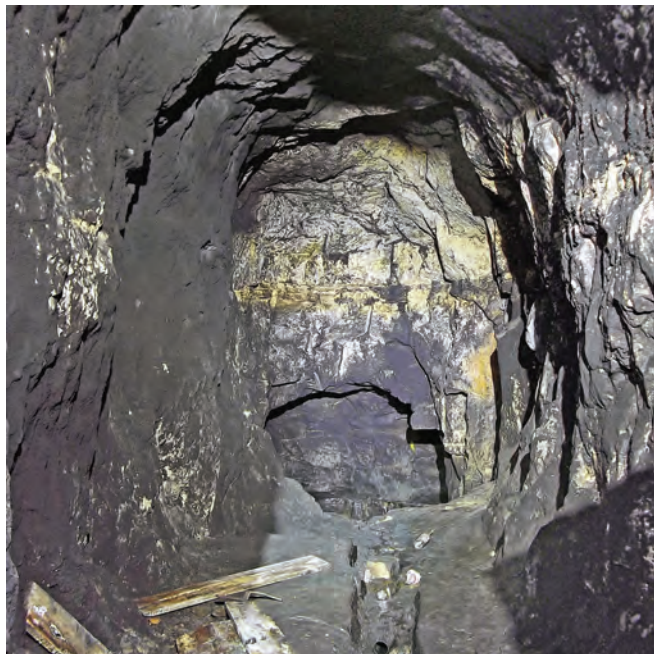
Nicholson railway tunnel showing the support vehicle's tyre tracks and one of the ceiling safety barriers at each adit.

Photo Adrian Armishaw

Heading up the concrete steps we passed through a rusty cage door and into the Nicholson tunnel of 1843. A large airy space with a compacted floor, the tunnel easily fits the Transit van that shadows the boat. Tyre tracks mark the floor with no sign of rails or ballast. The tunnels have very little graffiti, with the majority of markings coming from BR engineers and later tunnel checks.

At regular spots in the tunnel, there are roof sections with reflective stripes, marking the emergency adits. Wires and cables are stapled to the walls and iron numbers mark the distance remaining to the Marsden end.

As we walked up the tunnel, we saw regular refuges, a necessary build in a single-track tunnel, where there's not much space between the wall and the oncoming trains. The walls and ceiling of the tunnel were thick with soot and black dust hung in the air. There was little echo and the blackness was complete when Sub Brit torches weren't lighting the area.



Abandoned rock-cut adit leading from Nicholson tunnel to the canal side, showing substantial soot from passing steam trains. Photo Adrian Armishaw

Moving away from the parked Transit van, we saw traffic cones marking a rough cut in the wall. This is one of the access cross-shafts to the second railway tunnel – the Nelson tunnel of 1865. Low and unfinished, the cross-tunnel was a tight squeeze and the hard hats came in useful to avoid injury. The group emerged into the Nelson tunnel and found it almost identical to the first.

This tunnel is accessible by vehicles but is only used to train emergency personnel. The floor was still made up of original ballast and the soot was if anything even thicker. The tunnel is unrestored and seems identical to how it looked when the tracks were removed.

On our way back to the boat an unrestored adit was found and photographed by Adrian Armishaw. As we moved from Victorian times to the modern adit, a variety of safety signage was visible, some dating to British Rail times, some more recent. As London termini are 'UP' in the LNWR system, the two single-track railway tunnels were Up and Down South and the newer double-track tunnel was known as the North.

We rejoined the boat for the final section of the canal tunnel, watching out for the iron numbers fixed to the roof, marking the number of yards travelled from the



Nelson tunnel. Photo Adrian Armishaw

Diggle end. We moved quickly towards the light, damp and chilled as our trip had taken over two hours. The brightness took some getting used to as we emerged and moored by the Tunnels end tea room.

Some of the group took the opportunity to visit the heritage centre nearby which, although unstaffed, had a decent range of information boards about the tunnels and some items used during construction or found in the tunnels.



The rear tug pushing the specially built boat out of the Marsden end of the tunnel. Photo Adrian Armishaw

Marsden itself is a pretty town with a few shops and areas of interest. When walking around the streets, the regular signage for emergency tunnel access points and refuge meeting spots shows how the four tunnels have shaped the town and continue to exert a significant influence.

Short trips into the tunnel portal are available most days from the Marsden end but if possible a through trip would be much preferable for Sub Britters who might feel short-changed by a fifteen-minute glimpse. The longer trips are regular and advertised on the Tunnels website, although they do not include exiting the boat or visiting the railway tunnels.

At the end of our trip we were offered the chance to purchase copies of Trevor Ellis' excellent book on the tunnels – an invaluable resource if you have agreed to write up the trip for *Subterranea* !



Sub Brit members awaiting boarding at the Tunnels end tea shop – visible in the background is the old transhipment warehouse, now the tunnels visitor centre. Photo Bob Clary

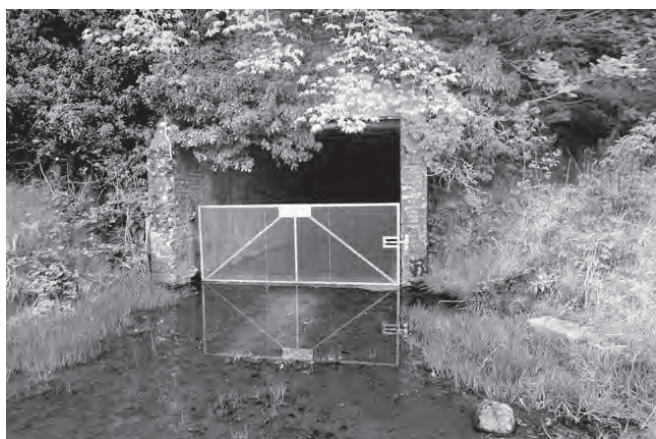
Grateful thanks

Throughout our visit and trip, the guides, volunteers and Canal and River Trust employees were unfailingly brilliant. Adapting standard tours to Sub Brit visits is always complex for attractions but everyone involved stepped up and ensured our visit was a highlight of the year.

Thank you to Martin and Linda for organising the trip, to the Canal and River Trust, all the guides and volunteers involved and especially Trevor Ellis who made the tunnels come alive with stories and anecdotes of his years under the Moor. Trevor's superb book *The Standedge Tunnels*, published in 2017, is available at cost price from the publisher (Huddersfield Canal Society) or the author himself.

Lochaline Silica Sand Mine in Argyll to reopen

The reopening of the silica sand mine at Lochaline has been reported. The mine workings cover around 370 acres accessed by around 48 km of tunnels, lying under 150 metres of basalt. The Lochaline sand is amongst the highest quality available in the UK – 98.8 percent quartz with a grain size ranging from 100 – 500 microns and with almost negligible impurities. The position of the mine – on the shores of the Sound of Mull with the facility for direct shipping out – is another commercial advantage. When the mine was closed in 2008 by its former owners Tarmac, eleven jobs were lost – six underground and five surface posts. It is now being sold to a joint venture comprising the international NSG Group (whose UK identity is Pilkington Glass) with Gruppo Minerali Maffet, an Italian mining company.



The high-quality silica sand at Lochaline is destined for use in the production of solar glass panels and the new owners expect something a production life of over ten years from the mine. The plan is to have the mine ready to reopen in April 2012, shipping out 100,000 tons per annum to St Helens in Merseyside, for specialist glass production there.

In the 1920s the Edinburgh Geological Survey did an analysis of a Lochaline sand sample – returning a result

of 99.69 percent silica. But at that time imported silica sand was quite cheap and Lochaline's remoteness made the overall cost of extraction uneconomic. What changed the fortunes of the mine was the outbreak of World War II and the sudden need for high-quality optical glass for military instruments and gun sights and for chemically resistant laboratory glass.

By 1940, under Charles Tennant & Co from Glasgow, management and staff were on site, with some of the necessary equipment brought to Lochaline from the legendary slate quarries at Ballachulish which Tennant also owned. The impact of the needs of war had reduced production at Ballachulish so some of its gear met this other useful purpose, away to the west, across Loch Linnhe at Lochaline. By 1945 the mine had produced some 35,000 tons of silica sand

And today, in the Autumn of 2011, that same firm, now part of NSG Group, is renewing its relationship with the Lochaline mine, as it starts up for a second time. An indication of the differences in working practices between then and now comes from comparing the anticipated production output under Pilkington's from April 2010 – 100,000 tons per annum.

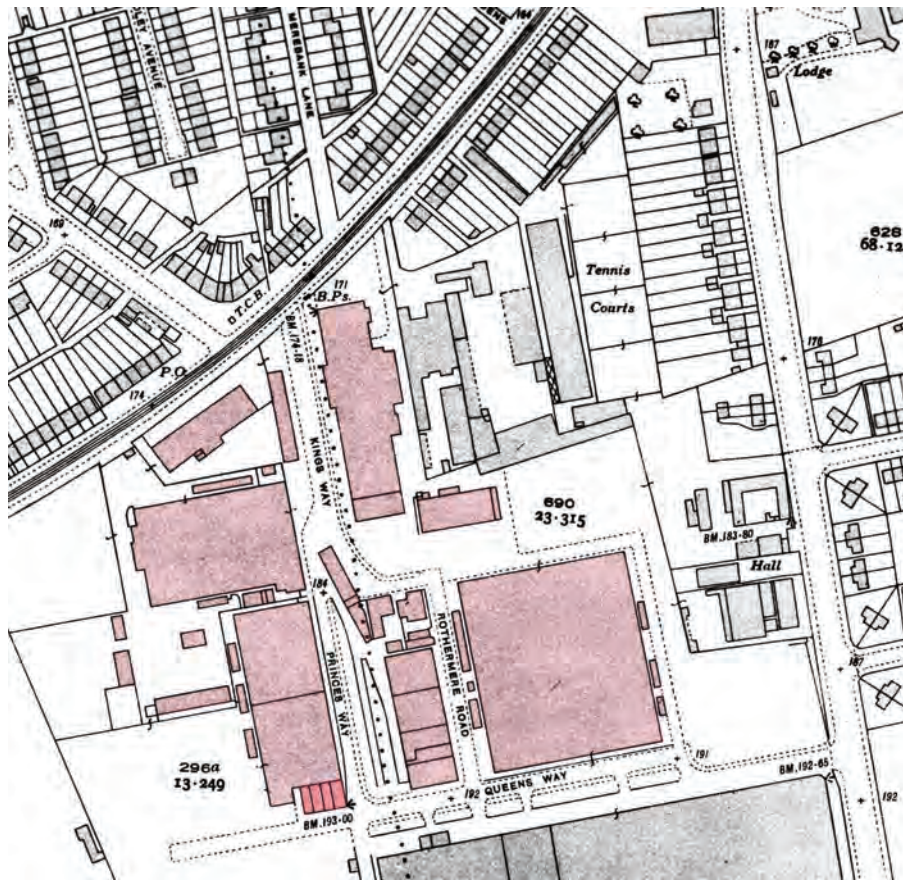
SOURCE: www.forargyll.com website, 15 October 2011.



National Aircraft Factory No 1 (Croydon)

- A new tunnel discovery

Ian Walker



1931 1:2,500 OS map showing the buildings that made up NAF No 1.

All have now been demolished apart from the substation which is darker red.

Croydon Airport, south of London, opened in 1920 and was developed in the interwar period as Britain's major and only international airport. It combined two previous aerodromes, Waddon and Beddington, the base of the Royal Flying Corps. National Aircraft Factory (NAF) No.1 was established at Waddon. The airport closed in 1959 and much of the site has been built over.

The National Aircraft Factory was a major forerunner on the site of the future Croydon Airport. The Historic Croydon Airport Trust has recently unearthed a major new find of some previously unknown construction of the factory that has not previously been recorded or reported. It is a very exciting discovery as it gives further insight into how the factory operated and appears to be an early development in large-scale factory design.

Demands of the First World War

The factory was one of three NAFs constructed and the only one that was a complete new-build factory on a greenfield site. It was built under the wider National Factory programme adopted by Britain during the First World War. Production across the manufacturing sector at the time was falling short of the supply demands of the war effort.

To address this issue, the 1915 Munitions of War Act was passed by Parliament which, amongst other measures, led to the creation of the Ministry of Munitions. David Lloyd George was appointed as Minister at its head. The Act gave the Ministry far-reaching powers which ultimately led to the control of all factories involved with war production and the rapid construction of new factories to attempt to meet the shortfall in supply.

It was under these auspices that work began on the National Aircraft Factory No.1. There is a very informative chapter about it in the first Doug Cluett book *The First Croydon Airport 1915-1928*.

Back to the story of the tunnel discovery. We were very fortunate to have been contacted by Neil Hollis, Manager of Restore Storage, located on Princes Way, on the Waddon Industrial Estate. Neil informed us that underneath their building there were some brick and concrete tunnels.



The first orders from the Air Ministry were for the De Havilland DH9 bomber. The first of the DH9s, D451 is nearing completion in March 1918

This remarkable discovery was a network of tunnels routing underneath the roadway connecting to multiple factory units along Queensway and at least pre-dated the Second World War. Further contact with Neil led to the offer of a personal inspection of the tunnels.

I met with Neil at their Princes Way site on 7 November 2018 to take a closer look. There were two possible entrances to access the tunnels but unfortunately the more accessible of the entrances was blocked by a parked car.



This left a quite tight entrance down a short vertical route into the tunnels.

Tunnel vision

The original iron ladder, installed when the tunnels were constructed and now over a hundred years old, was still, just about, in place. It was barely attached by one very rusted and corroded rail. The other side of the vertical rail had long rusted through and it was now swinging quite freely from what survived of the remaining rail. We thought better of entrusting it with our weight for the short climb down.



During WWII the tunnel was used as an air-raid shelter and signage from that period survives. Photo Ian Walker

A sturdy aluminium ladder was found to help us on our way down the short descent into the tunnels. The roof of the tunnel was only about three feet below road level. It was a short climb down into the tunnel and a step back in time.

It soon became apparent that these tunnels pre-dated the Second World War and were constructed in 1917 as part of the National Aircraft Factory No.1. Now over a hundred years old they are an extraordinary find and a part of the expansive factory site that was unknown to exist.

Power supply

Further exploration of the tunnels shed light on their purpose. They were constructed as service tunnels to



The brick-lined tunnel remains in good condition. Photo Ian Walker

provide an electric power distribution network to the various factory units of NAF No.1. The tunnel from under Restore Storage led some 30m directly into the electric substation located on Queensway. The substation is still in use to distribute electrical power to the area.

The height of the tunnels is around two metres with a similar width. The walls are built of brick with concrete floors and a concrete roof formed using a shuttering technique. The imprint of the wood grain from the shuttering can still be seen on the concrete. The floors were generally dry with some occasional large puddles of water.

The tunnels route southbound under Queensway but are now blocked up as they enter the factory units on the south side. The same scenario is repeated for the tunnels that would have led into the factory units on the north side of Queensway.

Fixed into the walls along one side are timber cable-carriers designed to carry the power cables routed to various units of the NAF No.1. There are some cables that appear to be from the original installation of the factory. The cables themselves were manufactured by Callender's Cable and Construction Limited.



The tunnels led into the electricity substation located at the junction of Princes Way and Queensway and this is the only section of that part of the factory that survives

The cables are very heavy duty, around 75mm in diameter, constructed using twisted heavy gauge steel strands and insulated with bitumen. Callender's was originally an importer and refiner of bitumen that had branched out into cable manufacture in the 1880s. They would later go on to be a major contributor to the construction of the National Grid during the 1930s.

The power cables fed vertically down through the substation floor via square apertures cast into the floor that exited into the roof of the main tunnel. Power was supplied at 2000 volts single phase and 1100 volts three phase transformed to 200 volts for lighting and 440 volts for power.

Century-old sub-station

The sub-station building is of original 1918 construction. It has had some minor modifications over the years but these are mainly superficial. Some windows have been bricked up and the roof fabric and lanterns have been changed. The roof itself is in poor condition and leaks large volumes of water when it rains.

Water and high-voltage electricity seem to be a poor combination but it has been in this poor state for many years. The building can be still viewed along Queensway adjacent to the MAIL 23 Industrial Estate.

The tunnels were also put to good use in the Second World War when they would have most probably doubled up as air-raid shelters. There is painted signage on the walls with directions to different sections of the tunnels and emergency exits. There were also some lavatories installed with some very cosy block work for privacy.

We have approached Historic England to consider



WWII signage survives in the tunnels. Photo Ian Walker

the tunnels for Listed building status. We'll keep you informed of progress.

Reproduced with permission from *Historic Croydon Airport Trust Journal En Route 146*, 3-4.

Lavant caves, West Sussex

Paul W. Sowan

The so-called Lavant 'caves', excavated in chalk for an unknown purpose at an unknown date, were apparently re-discovered as a result of a collapse in a field, the property of the Duke of Richmond, in 1892. They were famously the subject of archaeological investigations, commissioned by the Duke, by Charles Dawson [1864 – 1916] assisted by John Lewis [c. 1835 – c. 1915]. Dawson was later, in 1913, to attain international fame for his discovery, or 'discovery', of 'Piltdown Man', and 40 years later notoriety on the bone fragments being exposed as a fraudulent manufacture.

Dawson was assisted at Lavant (and at other sites) by one John Lewis, who had been born in Brighton in 1835 or 1836, and was described as a civil engineer. The excavations, conducted in January and February 1893, consisted of sinking a 'shaft', constructing a secure entrance, and excavating about a hundred feet of the east side of what appeared to be a more extensive labyrinth. A surviving photograph apparently taken in 1893 by John Lewis (published by Farrant) shows Dawson and workmen at an 'entrance to Lavant Caves' taking the form of a steep-sided entrance cutting around eight or nine feet deep and about seven feet wide, leading into a cavity in rising ground. A sketch drawing published in the *Daily Graphic* of 6 April 1895 but captioned 'Examining the debris for relics', probably based on the photograph, presents a close-up view of the entrance to the cavity, which gives the impression that the 'secure entrance' was in fact a flight of paved steps down rather than a vertical shaft. A further sketch drawing in the same newspaper depicts men underground, the headroom represented, from the height of a standing man, as of the order of ten or twelve feet. A 'Rough plan of the Lavant Caves' dated February 1893 (also published by Farrant) indicates there to have been two entrances. Curiously, the north point

on this plan points downwards, and there is no scale. The 'caves' appear to have been on the west side of a north-south road, mostly on the east side of a hedgerow, and south of an 'old waggon track' on the southern flank of Hayes Down. North of the caves a 'large excavation' (presumably an open chalk pit) is shown. The 'caves' themselves appear as an irregular network of seven or eight small tunnels, with slightly wider parts at three places. Shading indicated that around half the discovered network had been 'explored' (apparently meaning the chalk debris on the floor had been excavated and searched for finds). One roof-fall is noted, and there were two tunnels marked 'unexplored' leading to east and west. No formal archaeological report of this excavation was published, the main published contemporary source of information being an article in a local newspaper.

SOURCE: FARRANT, John H., 2013, Prelude to Piltdown: Charles Dawson's origins, career and antiquarian pursuits, 1864 – 1911, and their repercussions. *Sussex Archaeological Collections* 151, 145 – 186.



Charles Dawson and labourers at the entrance to the Lavant caves, probably in January or February 1893. Photo John Lewis



The Great Creswell Crags Witch Mark Discovery

Ed Waters and Hayley Clark

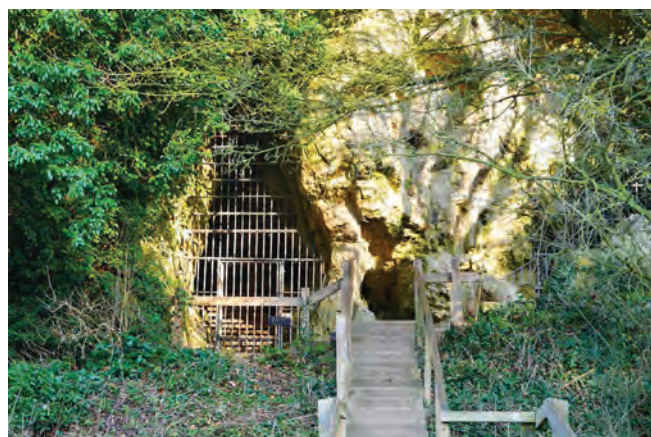


*Hayley Clark climbs the 5m pit towards the main concentration of RPMs, note examples at top right.
Photo copyright Charlotte Graham Photography*

This extraordinary story starts with the Sub Brit autumn meet in Nottingham last October. This was our first time attending this event, and we very much enjoyed the mixture of fascinating talks, the odd beer and superb company. There was even the chance to go underground every now and then, one of the included trips being to Creswell Crags, an important prehistoric site which lies on the Nottinghamshire / Derbyshire border.

The site comprises a spectacular limestone gorge, in the walls of which are found numerous, though not very extensive, caves. These caves are famous for their prehistoric archaeology, including the only known examples of Stone Age rock art in the UK.

Given that Creswell Crags is some distance outside Nottingham, the trip involved organizing a gathering of Sub Britters onto a coach, an exercise that has a lot in common with herding cats. As a result, we arrived somewhat (very) late for our booked tour of Robin Hood Cave. We were taken underground by guide John Charlesworth who provided an informative and entertaining narrative about the cave and its archaeology.



*Entrance to Robin Hood Cave, Creswell Crags.
Photo Ed Waters*

However, our group was rather large and the two of us found ourselves at the back of the group, almost out of earshot of John. So we amused ourselves by looking closely at some graffiti etched into the cave wall by visitors from long ago. Within a few minutes we had identified markings of the sort we had hoped to find, and were soon engrossed in our discovery.



We were so intent on the faint markings that we didn't really notice the others leaving the cave, and we were brought back to reality by John asking us what we were doing as he passed us. Hayley responded by saying, "*Do you know you might have witch marks in this cave?*"



Faint markings scribed onto the wall of Robin Hood Cave. These were the first marks noticed by the authors in October 2018. Photo Linda Wilson via Darkness Below

John seemed interested, in a polite kind of way, and suggested we have a chat when we got back to the visitor centre. Unfortunately, due to the lateness of our arrival there was a general rush to get back on the coach to Nottingham and there was no time to speak to John. We thought no more about that off-the-cuff remark from him.

What are Witch Marks?

So what are *Witch Marks*? The term is a little misleading, for they really have nothing to do with witches as such, but are symbols or letters intended to protect individuals from malign forces.

Academics tend to refer to them as *Ritual Protection Marks* (RPMs) or *Apotropaic* marks or symbols (from the Greek meaning 'to turn away'). Such marks are well known from buildings dating from the 16th to 18th centuries, frequently appearing in places where evil spirits could enter, such as windows or fireplaces. There are a number of different such symbols including the Daisy Wheel (*see photo*) and various combinations of letters now recognized as RPMs.



Roadside shrine on La Palma covered in Apotropaic symbols. The symbols on the pillars to each side of the arch are "Daisy Wheels". Photo Ed Waters

Canary Islands discovery

So how did the two of us realize what we were looking at in Robin Hood Cave? Well, we have a fairly broad interest in the underground, and one of our speleological fetishes is the exploration of lava tube caves.

On a visit to the island of La Palma in the Canaries a few years ago we were driving along when another member of our party yelled at us to stop as he wanted a photo of a roadside shrine (*see photo*) as it was covered in Apotropaic symbols.

The passenger in the car was Chris Binding who was among the first to identify RPMs at underground sites in the UK. Along with Linda Wilson and Tim Easton, he recorded RPMs in various caves in the Mendip Hills in the early 2000s (Binding, Easton & Wilson 2005 and Binding & Wilson 2010).



RPMs in Robin Hood Cave; note date of 1717 bottom left. Photo Ed Waters

It should be noted that RPMs had been recorded in caves somewhat earlier (Cordingley 1999 and 2000 for instance) but their significance was not recognized. Chris waxed lyrical about RPMs over some local wine that evening, but the conversation would probably have gone no further but for a bit more serendipity.

Another member of the Mendip Caving Group (MCG), to which Chris and the authors belong, is Charlie Allison. Charlie had become very interested in the work of Chris and Linda and had started to look for RPMs at other sites across the Mendip Hills. Charlie's enthusiasm is infectious, and we soon found ourselves accompanying him to obscure caves to help record RPMs.

Ancient religious marks

During these trips Charlie showed us the typical things to look for, like the classic "conjoined V" which looks like "W". This is thought to refer to the Virgin of Virgins. The symbol is also seen upside down as an M when it is thought to refer to Mary. Perhaps unsurprisingly the



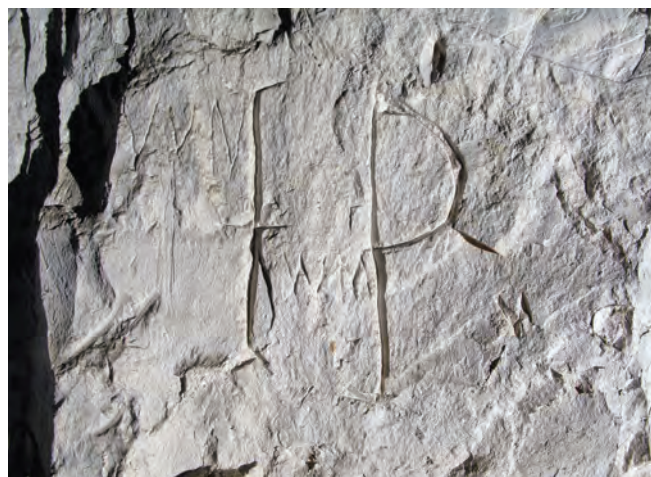
Charlie Allison photographing RPMs in Kent's Cavern, Torquay with Hayley's assistance. Photo Ed Waters

two are often found together invoking the Virgin Mary, and sometimes the M is prefixed by a P thought to refer to *Pace Maria* (Latin for the 'peace of Mary').

Another symbol often associated with RPMs is the "crossed I": I. This is in fact an early form of the letter J and thought to invoke the name of Jesus. It is often seen as an RPM in conjunction with other letters, notably B and P in our experience. As well as the types of symbol to look for, we also became accustomed to the kinds of places where RPMs can be found in caves.



Conjoined V, thought to refer to the "Virgin of Virgins" carved into sandstone in the Baron's Cave at Reigate. This symbol is also often seen upside down, thought to refer to Mary, sometimes together with the VV. Photo Ed Waters



Crossed I, an early form of letter J, thought to invoke Jesus. This example is in Emmer Green Chalk Mine in Reading. Also note the paired conjoined Vs surrounding. Photo Ed Waters

We also started to keep our eyes open for marks on our various trips to underground places throughout the UK, noting RPMs in many tunnels, mines and caves. We even noticed RPMs in photographs of graffiti taken by us many years before on various underground visits, such as that above in Emmer Green Chalk Mine. Thus, when we saw that faint conjoined V and M in Robin Hood Cave, we were pretty sure that it was an RPM that we had spotted.

Sub Brit forum to the rescue

Fast forward now to January 2019, when a request appeared on the Sub Brit members' forum for whoever had mentioned Witch Marks during the Creswell Crags visit to identify themselves. We duly admitted responsibility and we were put in contact with John Charlesworth, the guide who had taken us into the cave back in October.

Far from being just polite, John had taken our comment very seriously indeed and had carried out a great deal of research into RPMs, and also realized that there were many more not only in Robin Hood Cave, but also in many of the thirty or so other caves at Creswell.



Hayley examines RPMs in Robin Hood Cave. Copyright: Charlotte Graham Photography

John had engaged with academics to be sure of his ground, but it was soon apparent that far from a single faint example, Robin Hood Cave contained a profusion of outstanding RPMs, indeed the quantity of marks is the greatest known of any underground site in the UK.

Creswell Crags' management was excited (to put it mildly) about the find, and a press event was duly organised on 14 February 2019 to announce the discovery. The reason for the contact with Sub Brit was so that we, as the discoverers, could be part of that event. So we travelled north, not knowing quite what to expect other than there would be a lot of press and TV journalists in attendance. John took us into the cave first thing in the morning, which was an amazing experience. We had seen nothing of the main part of the find which lies away from the area shown to the public. The most significant concentration of RPMs occurs at the top of a 5m-deep pit accessed by a narrow crawl.

The rest of the day, and most of the next, were spent providing interviews for a bewildering array of newspapers, radio and TV stations. That the news was going viral became clear as we sat down, knackered, to our Valentine's dinner with Hayley's phone constantly buzzing away as various requests for interviews, quotes or to appear on radio came in.

Worldwide interest

By Friday morning the story had gone international, appearing in newspapers all over the world and making it onto the ITN national news, with Sub Brit getting a great deal of positive coverage, despite the constant media hype of the discovery of the "Gateway to Hell". All in all, a decent result considering it all flowed from an off-the-cuff remark concerning some faint graffiti on a cave wall!

The postscript to this is that research into RPMs in underground sites is still relatively new and not widely known. The Creswell find has increased interest, and there is a small core of people involved and actively

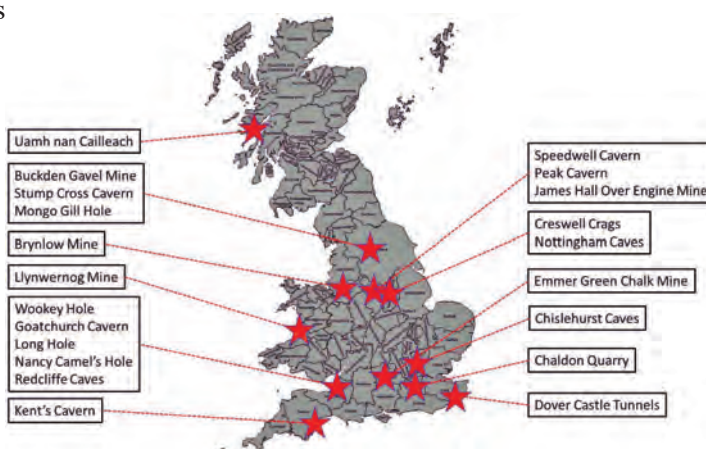
researching them. However, it is clear that many more spectacular finds are yet to be made underground across the UK.

RPMs have been identified in caves, tunnels and mines throughout the UK and if the members of any organization are likely to come across them then it is Sub Brit!

So, next time you see some odd graffiti take a closer look. RPMs are often mistaken for the initials of early explorers, and in all fairness are often mixed in with them and it can be difficult to tell apart. However, it doesn't cost much time to take a photo and post it on the members' forum, or write a short note for *Subterranea* as a record.

We would of course be more than happy for people to send photos to us to pass on to our academic friends for comment. Or we could even come and have a look – any excuse to visit a new site!

UK location map



Map showing locations in the UK where RPMs have been identified or suspected. The majority are from personal observation, others are from the references below.

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BBC East Midlands reporter Quentin Rayner (left) and John Charlesworth (right) balanced precariously at the top of the 5m pit. The roof and walls of the cave are festooned with RPMs at this point. Photo Ed Waters



Private air-raid shelters at Sutton Coldfield

Adrian Armishaw



First shelter entrance

At the beginning of 2019 Sub Brit received an enquiry about a pair of air-raid shelters which had recently been discovered in the back garden of a prewar house in Sutton Coldfield in the West Midlands. On 23 February I went to meet local residents and researchers Roger and Sue Harris who had made the enquiry and who had also now kindly arranged a visit to the site with the home owners.



Looking out of the first shelter, the gas-proof door is seen and, to the right, steps up to the upper landing. Note the metal conduit for power cables. To the left of the door a 5A 3-pin power socket and switch is seen with two light switches to the right of the door. A Wigan bulkhead light is seen on the upper landing.

Unexpected Discovery

The couple who recently bought the property became aware of the previously unknown shelters when their gardener was clearing undergrowth and her rake went down a hole. Fortunately the owners are not only sympathetic to the shelters remaining, but are genuinely interested in their history and future preservation.

The first shelter is a short distance from the house; there is a flight of nine brick steps leading to a landing with a drain in the floor. This turns left and then right where a further flight of five steps takes you down to a small area outside a steel gas-proof door. An Elsan chemical toilet was discovered in a recess to the right of the door, complete with a preserved original toilet roll. Passing through the gas-proof door you step into an arched steel-lined chamber.

The walls and roof are formed from interlocking curved steel sheets which join at the apex by slotting into either side of an RSJ. Each end of the chamber is formed from a series of steel trays which are joined together with bolts through the flanges of each edge. There is a raised timber floor which produced a strong smell of creosote when the small amount of water in the shelter was removed.

The water would appear to have entered via the backfilled entrance rather than having seeped in from below despite the structure having been constructed relatively deeply for a domestic shelter.



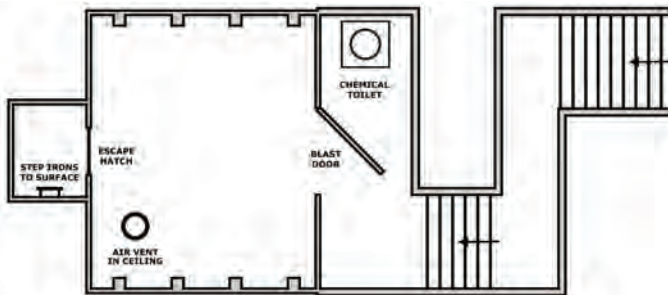
Looking towards the emergency exit with step-irons (seen on the left) up to a hatch in the garden. A Wigan bulkhead light is seen fixed to the ceiling. The air vent can just be made out in the ceiling.



Emergency Exit

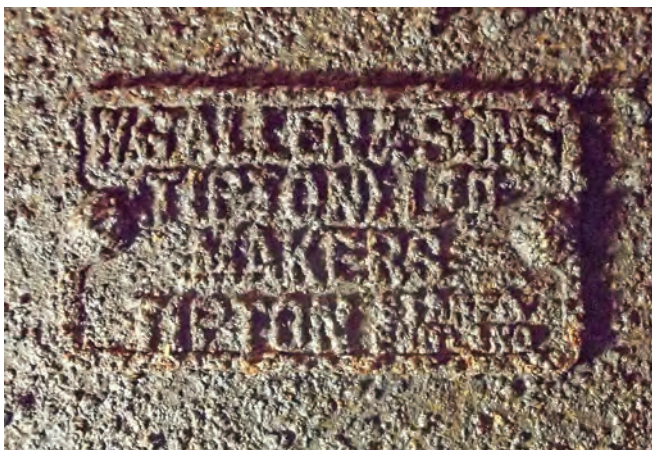
At the far end of the chamber is an emergency exit hatch consisting of a steel plate which engages in a slot at the bottom and is held in place by two levers at the top. Beyond this there is a brick-lined escape shaft with four steel wall steps leading up to a manhole exit. The shelter was provided with mains power and is fitted with 'The Wigan' pattern bulkhead lights on the landing and in the main chamber, where there is also a power socket.

The overall quality of construction in steel and the provision of power had led to some speculation as to its original purpose. This was increased by the similarity of the floor plan to an Auxiliary Unit operational base.



It was also possible that it could have been built for either Civil Defence or Home Guard use. Research by Roger had revealed that the wartime owner of the house was also the owner of a Birmingham engineering company which could have given him access to the necessary building materials.

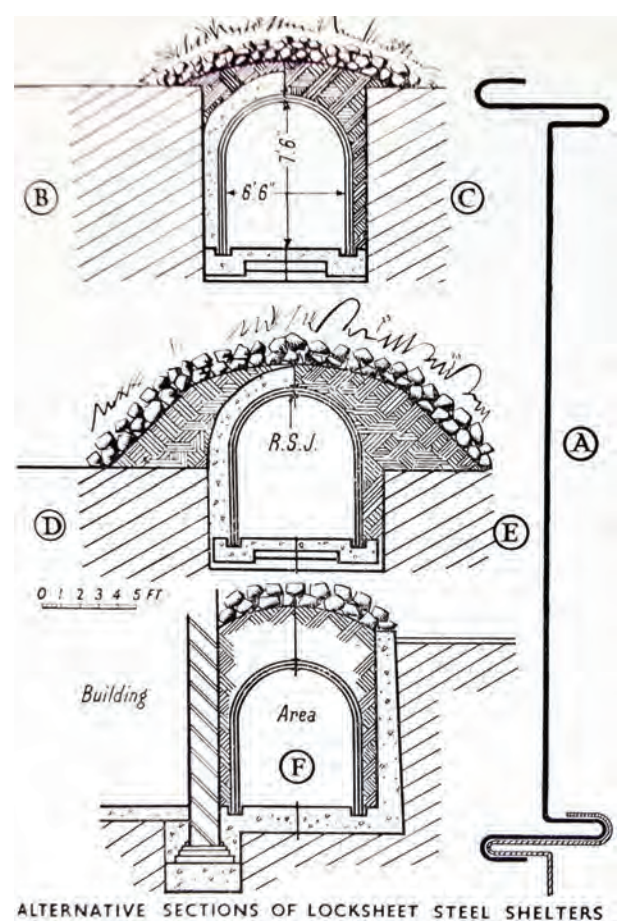
The construction of the main part of the shelter in steel would suggest an early date as the supply of these materials and the labour to build it would have been restricted once the war had begun. The gas-proof door carries a plate bearing the name of W.G. Allen & Sons of Tipton.



Gas-proof door makers plate W.G. Allen & Sons of Tipton

During his research, Roger had found an original advert for this company which showed that they mostly supplied heavy equipment for the mining industry. The advert also showed a steel fire-watcher's post and advertised the supply of patent 'Locksheet' air-raid shelters.

W.G. Allen & Sons advertisement



ALTERNATIVE SECTIONS OF LOCKSHEET STEEL SHELTERS

Page from Richard Costain Ltd's air raid shelter brochure

German recommendation!

Following this lead revealed that in the late 1930s Richard Costain Ltd were promoting this design to local authorities for public protection. Intriguingly their company brochure from 1938 advertising shelters includes photographs of Locksheet shelters under construction, but used with permission of the Advisory Department for the Utilisation of Steel in Düsseldorf.

The brochure refers to the use of this design of sheeting in the mining industry, in which the Germans were technological leaders, and this would explain the connection with W.G. Allen, who probably supplied, rather than manufactured, the shelters.



Photo from the brochure of a curved steel sheet shelter similar to the one at Sutton Coldfield.

Locksheet steel sheeting is made from 14 SWG copper alloy steel; the copper content was intended to increase its durability and resistance to corrosion. The sheets interlock, creating vertical structural ribs at the joints through the use of S sections formed on each edge. They are joined at the top of the arch by slotting into the sides of an RSJ measuring 7" by 3"; the sheets thus form an arch 6' 6" across by 7' 6" tall.

The sheets were produced in 2' 3" widths at a cost of £6 per sheet (in 1938) and the gas-proof door was available for £11: 6s. This at a time when the average weekly wage for male manual workers was £3: 10s (£3.50).

Second shelter

There is also a second shelter in the far corner of the garden. This one is of more conventional square brick plan and is entered down a flight of steps with a door on

the left at the bottom. There is again an escape hatch in the far wall with a hinged steel door and vents in opposite walls beneath a flat concrete roof slab.



Entrance to the second shelter

It is not clear whether one shelter was constructed before the other and if so, which was built first? It could be that the brick shelter was built first, to be replaced by an upgraded version closer to the house, or the steel shelter could have been built first and the brick one built later to provide greater capacity, perhaps following the arrival of additional family members or evacuees.



Emergency escape hatch in the second shelter

Conclusion

I conclude that the most likely explanation for the steel shelter is that it was a private shelter built at an early date to a very high specification.

I am extremely grateful to the owners for allowing my visit and also to Roger and Sue Harris for their research, the scale drawing of the shelter and for making the necessary arrangements. We would all welcome any thoughts or observations which might help to shed further light on the origins of this fascinating site.

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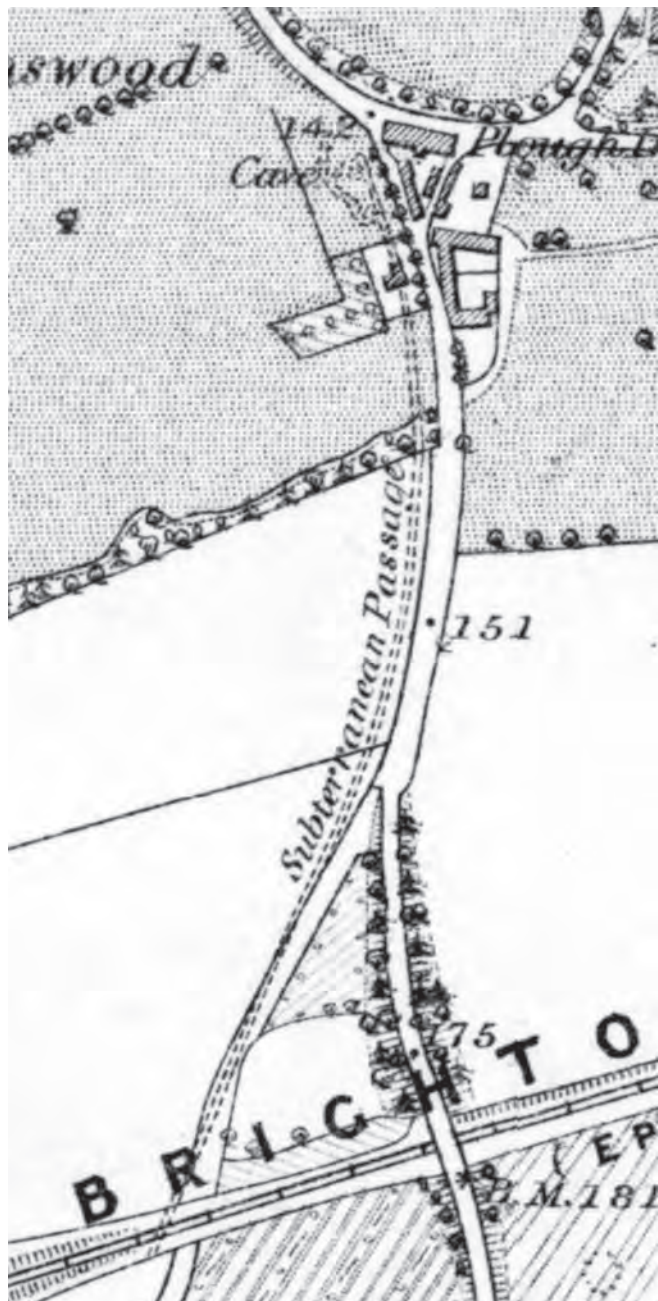
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Glover C.W. *Civil Defence*, Chapman and Hall Ltd. 1938
Colour photographs Adrian Armishaw.



Underground features on late nineteenth-century Ordnance Survey six-inch mapping

Richard Oliver

The following article was published in Sheetlines, the journal of the Charles Close Society, and is reproduced here with permission.



The caves and 'Subterranean Passage' at Beddington, as shown on Surrey six-inch sheet 14 (1872).

The Charles Close Society has recently received an enquiry from Nick Catford, concerning a cave and a 'Subterranean Passage' at Beddington, shown on Surrey six-inch (1:10,560) first edition sheet 14, stated to be surveyed in 1867–8 and published in 1872[1] He does not recall seeing such a cave system on any other OS map, and wonders if it is indeed unique.[2]

It is not possible to give a definitive answer, but it does seem that the depiction of cave and passage are



The Beddington caves in greater detail on 1897 1:2,500 map

highly unusual. This is the more so as the normal practice on similar mapping of Surrey at this time was not to indicate the course of railway tunnels. There is a striking example of this on sheet 26, where air shafts, spoil heaps and other

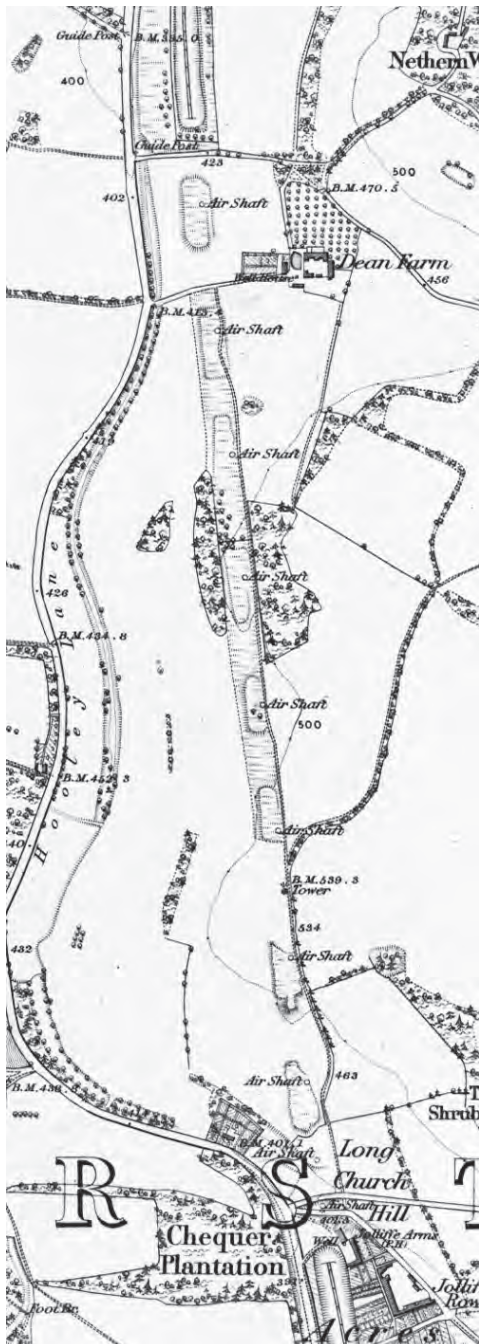
surface evidence of Merstham tunnel are shown, but the actual course of the tunnel is not, even though it runs dead straight and would not be a big survey problem.

Most of Surrey was mapped in the late 1860s by a division under the command of Captain William de la Poer Trench, who is the only 'survey employee' known to have gone on to be a Member of Parliament – albeit briefly.[3]

That there was not a consistent policy at this time is indicated by the treatment of tunnels in west Kent, which was surveyed under the command of other officers: on sheet 16 the curving tunnel south of Chelsfield (a 'survey problem') is mapped by a single dotted line, presumably representing the centre-line, whereas on sheet 17 a tunnel north of Eynsford is shown by a double dotted line, presumably denoting the sides of the tunnel; on the Hither Green–Tonbridge line, Polhill tunnel is mapped on sheet 28, whereas the tunnel south of Sevenoaks is absent from sheet 40 though, as at Merstham, its course is hinted at by air shafts and other surface features.

A possible clue to the mapping of the Beddington 'Subterranean Passage' may be the treatment of caves at Reigate Castle, on sheet 26, and of 'Course of Hampton Court Water Works, constructed by Cardinal Wolsey' on sheets 6, 7 and 12. Although the 'caves' on sheet 26 are named in Old English writing, whereas Wolsey's conduit is named in ordinary italic, both are obviously 'antiquities'. This suggests that the Beddington caves and passage were also believed at first to be an 'antiquity', perhaps of uncertain date, though there is no known reference to them before the 1830s, and it is noticeable that the passage seems to end at the railway: is this just coincidence? [4]

Perhaps the caves and passage were treated as 'where surveyed in the field antiquities' and that this classification was revised when the manuscript drawings received their routine



Sheet 26 includes Merstahm tunnel

final field examination before forwarding for publication.[5] As the passage has multiple curves it would certainly not have been straightforward to survey.

That such things were surveyed at all may indicate an element of personal preference: Colonel Sir Henry James, Director of the Survey 1854–75, had strong antiquarian interests and, being of “forceful character” and “unpleasant if opposed”, had sufficient authority to ensure that apparent oddities were mapped even though they might divert resources from mapping features of more general utility.[6]

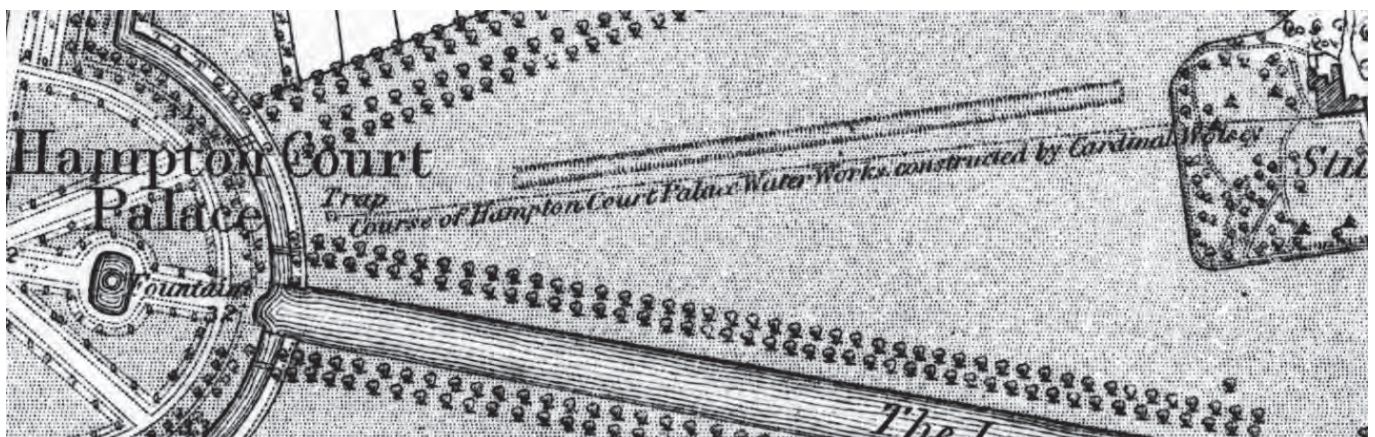
Whether Captain de la Poer Trench was sympathetic to those interests is not known, though Maurice Beresford has pointed out that the detailed mapping of deserted mediaeval villages in the East Riding of Yorkshire, in contrast to their neglect in Warwickshire, was owing to the personal interest of Captain John Bayly.[7]

The Beddington caves and passage appear also on the revisions of the 1:2500 made in 1895 and 1911, though not on those of 1933 or 1941. This suggests that the passage was still accessible up to at least 1911. The earliest Ordnance Survey instructions bearing on such problems date from 1932, and the wording in 1952 is similar: ‘The entrance will be surveyed... The underground passages in caves will not be shown unless they are used as thoroughfares, in which case they are shown as tunnels.’[8] If similar instructions were in force between the 1860s and 1911, then that suggests that the Beddington passage was readily accessible.

Readers who have encountered similar apparent anomalies elsewhere are invited to comment.

References

- 1 References here are to the six-inch map; the field survey was at 1. The caves and all but the southern end of the passage are on Surrey sheet 14.9 (Beddington parish), the southern end on sheet 14.13 (ditto), and comparison shows the six-inch to be an acceptable surrogate.
- 2 The cave is at about TQ 30076482.
- 3 He was member for Galway 1872–4: at the election of February 1872 he was heavily defeated, but gained the seat in June following a petition. He was defeated at the general election in 1874. He was the third son of the Third Earl of Clancarty, and such a ‘titled’ connexion is certainly unusual for a ‘survey officer’.
- 4 Paul W. Sowan et al. ‘Waddington and Beddington Caves’, *Subterranea* 48 p49. I am indebted to Nick Catford for this.
- 5 As the relevant field documents are not extant, it is impossible to prove or disprove this. Survey and initial publication were at 1:2500.
- 6 Richard Oliver, *The Ordnance Survey in the nineteenth century*, London: Charles Close Society, 2014, 240–3.
- 7 Maurice Beresford, ‘The spade might soon determine it’: the representation of deserted mediaeval villages on Ordnance Survey plans, 1849–1910, *Agricultural History Review*, 40 (1992), 64–70
- 8 Instructions for Detail Survey, Revision and Examination of Large Scale Plans (The Red Book), 1952, section C85: printed for internal use only: copies at British Library Maps 207. aaa.17 and The National Archives [Kew], OS 45/54.



Course of Hampton Court Water Works on Sheet 26



